REFINING • PETROCHEMICALS • NATURAL GASOLINE

Petroleum Refiner

NOVEMBER
1957

1957 PETROCHEMICAL HANDBOOK

Outlook for Petrochemicals 194

95 Process Descriptions with 95 Flow Diagrams 206

REDUCED COSTS
How to Schedule Design Work . . . 313

TOP PLANNING
What it Takes to Be a Manager . . 363

For a "Quick Look" at this issue, turn the page . . .

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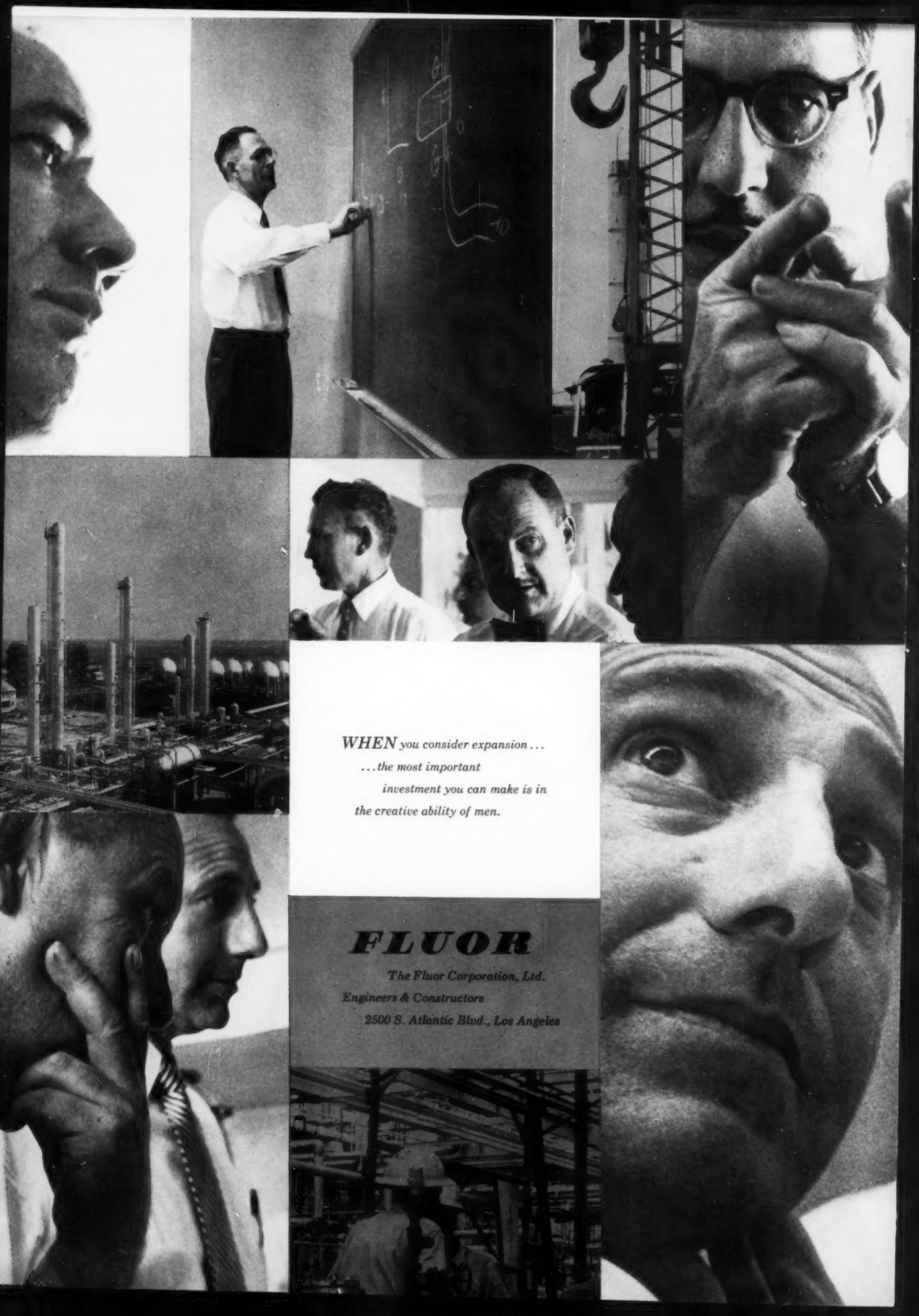

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Volume 36, No. 11 November, 1957

PETROCHEMICAL HANDBOOK

Foreword 193
Index to Process Section 194
Index to Separation Section 195
Index to Contributors 196
Petrochemicals—the Boom Continues! 197
Robert L. Bateman
Functional Fluids 198
Robert I. Stirton
Aromatic Hydrocarbons 199
J. J. O'Connell
Pesticides 200
Melvin Goldberg
Olefins 201
C. H. Thomas
Plastics 202
Gordon Brown
Fluorochemicals 203
J. P. Farrell
Synthetic Rubber 203
Harry L. Fisher
Synthetic Fibers 204
Frank J. Soday
Synthetic Detergents 205
Foster Dee Snell
Process Section 206
Separation Section 292

OTHER FEATURES

Automation Today (Part 14) 305
Theodore J. Williams
Compressibility Factors at Low Pressures 309
H. W. Pfennig and John J. McKetta
Reduce Costs by Scheduling Design Work 313
H. T. Campbell
Know Your Asphalts (Part 3) 316
E. J. Barth
Good Tube Maintenance Tools Cut Costs 317
A. John
Fluid Catalyst Design Data (Part 8) 321
Frederick A. Zenz
Taking Stock 391
Cecil W. Smith

As Management Sees It . . .

The ABC's of Better Writing 361
John L. Kent
What It Takes to Be An Executive 363
Major B. Foster
What You Should Know About Fires 369
J. L. Risinger

DEPARTMENTS

LOOK BOX, Featuring . . .
Ray L. Dudley, 1891-1957 185

Quick Look at Industry 181
Valuable Reading Ahead 330
How To Do It 332
Who's Building 340
If Oil Could Speak 376
What's Happening 378
Changing Times 386
Meeting Calendar 388
Men In Industry 392
Reviewing New Books 413
Suppliers' Notes 416
Classified Advertising 446
New Equipment 448
Manufacturers' Literature 448
Index to Advertisers 489
Readers' Service Card 491

Petroleum Refiner

REFINING • PETROCHEMICALS • NATURAL GASOLINE

A Quick Look at This Issue

These handy digests permit checking ☑ the articles you want to read first.

PETROCHEMICAL HANDBOOK

☐ **Petrochemicals—the Boom Continues! . . .** Why has the industry doubled every five years? What are the economics behind forecasted 1960 annual production of 60 billion pounds? Which petrochemicals offer the greatest potential for growth? For answers to these questions and important trends to watch, turn to Page 197.

☐ **Functional Fluids . . .** Synthetic hydraulic fluids and other functional fluids are some of the newer petrochemical products. Six major producers of these functional fluids are constantly improving their products and exceeding military specifications. Of significance in recent years have been the development of non-flammable functional fluids. For what to look for in the future, turn to Page 198.

☐ **Aromatic Hydrocarbons . . .** Only about 7 percent of the present reformer capacity is used to produce petrochemical raw materials. However, refiners are steadily installing more BTX extraction facilities. For trends to watch in aromatics, turn to Page 199.

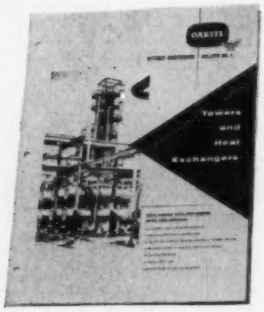
☐ **Pesticides . . .** Petrochemical derived pesticides—insecticides, fungicides and herbicides—have come into their own since World War II. Intra-industry competition has changed the distribution pattern as well as bringing newer formulations and products on the market. Federal legislation brings new problems. International health programs offers greatest growth potential. For a complete story on the past and future of the industry since 1950, turn to Page 200.

☐ **Synthetic Rubber . . .** The synthetic rubber industry is looking for about 5 percent increase this year. Butadiene co-polymers and butyl rubber have the best future. New rubbers and the polyurethanes should get their share of the market. To keep posted on the synthetic rubber race, turn to Page 203.

Please Turn Page ➜

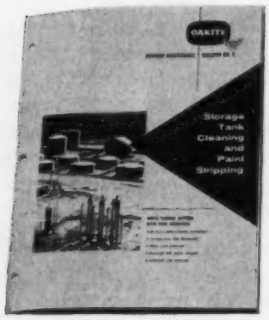
2 new refinery maintenance bulletins show the way to

save down-time in a big way!



Bulletin No. 1

Oakite chemical circulation cleaning of towers and heat exchangers described fully, with graphs and illustrations. Explains in-place cleaning with no dismantling, less down-time and greater safety to men and equipment.



Bulletin No. 2

Shows how to clean storage tanks and strip paint at least cost for time and material ... with thorough soil and paint removal, minimum product contamination. Charts, illustrations.

FREE! These valuable new bulletins are part of a series being published by the Petroleum Service Division of Oakite, covering typical refinery maintenance operations. They reflect the practical experience of Oakite men working intimately with the petroleum industry ... working toward better, faster ways to do the job. Get your free copies of these bulletins through your local Oakite man, or by writing to Oakite Products, Inc., 50B Rector St., New York 6, N.Y.

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☐ **Olefins . . .** The entire aliphatic segment of the petrochemical industry is based upon olefins. Ethylene is still the largest and has the brightest future. For the outlook on propylene, butylenes, butadiene, isoprene and propylene trimer, turn to **Page 201.**

☐ **Plastics . . .** This industry is just getting its "second wind". The next few years will see outstanding growth in all petrochemical derived polymers. For a revealing report on the future, turn to **Page 202.**

☐ **Fluorochemicals . . .** The rapid expansion of fluorinated hydrocarbons can be tied directly to mass acceptance of aerosol sprays. These uses, coupled with the new fluoropolymers, offer many new areas for expansion. Brief yourself on the present outlook, as well as future trends, turn to **Page 203.**

☐ **Synthetic Fibers . . .** Still leading the petrochemical industry in growth rate, synthetic fibers have been adapted to our modern way of life. Sales of synthetic fibers have increased 50-fold in the past 16 years to about 500 million pounds per year. Look for an 8-fold increase in the next five years. For new developments in this billion-dollar industry, turn to **Page 204.**

☐ **Synthetic Detergents . . .** Syndet production is up slightly over recent years. Liquid syndets continue to capture an increasing share of the market. For a clear picture on the synthetic detergent industry, turn to **Page 205.**

☐ **Automation Today (Part 14) . . .** Here are some of the things you will want to know before you start testing equipment for process dynamics and control. Methods are discussed for carrying out an examination of the equipment in operation. You will want to consider the best method of testing your particular process. See how the data are obtained by turning to **Page 305.**

☐ **Compressibility Factors at Low Pressures . . .** of ethylene, propylene and butene-1. Here are experimental data for pressures up to two atmospheres and temperatures from 90 to 150 F. You'll find use for these in your every day calculation work. Turn to **Page 309.**

☐ **Reduce Costs By Scheduling Design Work . . .** Detailed schedules predict the location of maintenance and construction employes. Such a program is ineffective unless dependable engineering design information is available. This article gives the important elements that make up design scheduling. For complete details, turn to **Page 313.**

☐ **Good Tube Maintenance Tools Cut Costs . . .** Here is a roundup of the tools especially designed for boiler and heat exchanger tube maintenance that makes cleaning and repair easy and cuts downtime for repair. For complete details, turn to **Page 317.**

Petroleum Refiner

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PIPE LINE INDUSTRY and The PIPE LINE COMPOSITE CATALOG for the oil and gas pipe line industry.

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Of This We're Made

WITH SOME REGULARITY our editors take time out to see if they are maintaining good editorial balance in PR's editorial content. You know our field: refining, petrochemicals, natural gasoline. Well, some time back we checked the 222 technical articles that appeared in our 1956 issues and found:

Not including Process Issue flow charts, 58 of the articles were of primary interest to refiners, 22 of primary interest to petrochemical people and 18 of primary interest to natural gasoline operators. Of the remaining 124, a total of 95 held interest for all three, 18 interested both refining and petrochemical circles and 11 were of joint interest to refiners and natural gasoline operators.

As we say, this "editorial balance" is something we watch from month to month. But it's good to look back now and then to see if on a long range basis we attained the goal.

"Papers" or MSS

EDITORS SOMETIMES are accused of trying to tell the other fellow how to run his business. To at least a degree this is true. Take for instance the matter of writing by professional engineers and others skilled in the processing field. Or the matter of whether a company encourages its engineers to publish articles from time to time in recognized technical magazines. Just whose business is that?

A book, "No Short Cut to Glory" by Kenneth A. Roe and H. A. Bergen covers these matters pretty well. They point out that engineers should support their professional societies and *engineering firms should foster participation in the societies and encourage committee work and the writing of papers* as a means to achieve greater public recognition for the engineer. (To this we would add, greater public recognition for the company, too!)

Obviously, of course, the more such papers written and published, the better we will like it. But we did want to quote two other fellows, neither a magazine publisher, who share our view. This is a matter of much importance both to individuals and companies. If your name is Thomas, why not let us see your "paper" (we call them manuscripts) so the point can be proved up?

This, the Petrochemical Handbook, which PR issues in alternate years, is the one you will want to hold onto for reference purposes. It contains:

- Flow charts of 95 manufacturing and 13 separation processes
- An over-all outlook for the entire petrochemical industry
- Specific forecasts on eight important petrochemicals.

So keep it handy after you've pored through its pages. If some non-subscriber tries to grab it, refer him to the pretty little card inserted between pages 2 and 3. If he requests, we'll do our best to start *his* sub with a copy of this special issue.

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Stainless steel so effectively turns the battle against corrosion that there is no question about the investment payout. To assure long life, Type 304 ELC stainless was selected for this 90′ stripper column. Shop-fabricated by Graver in two sections and field-welded into one unit, the column was random-radiographed and tested to pressures of 162 psi. and 246 psi. Graver's expertness in fabricating and welding stainless is always assurance of trouble-free service.

to turn the battle against corrosion!

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For more data on advertised products, use Readers' Service Cards, last page.

Walworth Lubricated Plug Valves

big ones . . . little ones . . . and all sizes in between . . .

ready to ship within an hour!

Large Plug Valves for pipeline and refinery use await shipment from our Garland warehouse.

Walworth Lubricated Plug Valves are carried in a complete range of pressures and sizes from ¼" to 12" in our Garland, Texas warehouse. From this central point, orders are filled within an hour after they are received and shipped by fast motor truck delivery to any place on the North American continent.

Of course, your local Oil Well Supply Store maintains a representative stock of Walworth Lubricated Plug Valves in sizes and for pressures most in demand locally. But if your needs are unusual, either in quantity or in size and pressure, your local "Oilwell" representative can arrange for fast delivery.

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HOW EDISON'S OMNIGUARD PREVENTS PUMPING STATION SHUTDOWN FOR SUN OIL

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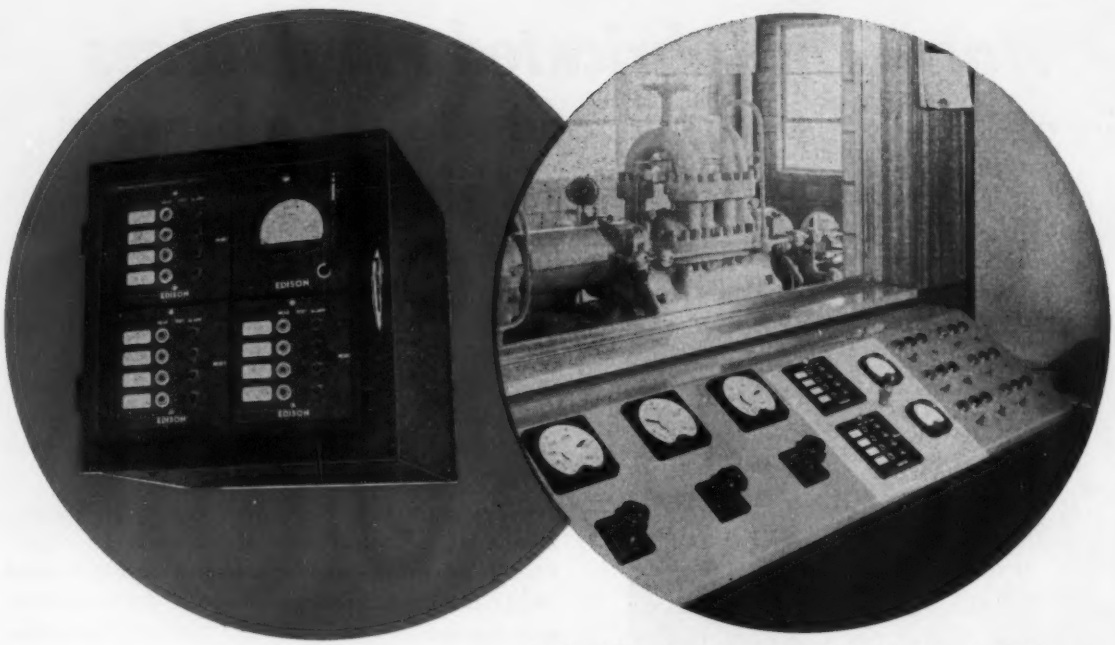
The Edison Omniguard is used by Sun Oil for alarm and control purposes in connection with the operation of two major pieces of equipment — a 500 hp motor and a 6 stage centrifugal pump. Seven points are under constant surveillance by the Omniguard apparatus; namely, the two motor bearings, the two pump bearings, the two pump seals, and the pump case.

The alarm system at each point is pre-set for a given temperature, automatically warning the operator of any rise in temperature beyond the pre-set point and simultaneously shutting down the unit to prevent damage to major equipment in the pump station. All Omniguard temperature controls are located in a desk type console installed in the control room.



The following Omniguard features prompted Sun engineers to specify it for the Oakland installation:

1) Fast response
2) Quick adjustment of pre-set points
3) Ability to alarm and/or shut down selected points
4) Small physical dimensions of the sensing element
5) Explosion-proof construction at sensing element
6) Associated equipment can be installed immediately

Write for more technical details to:

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For more data on advertised products, use Readers' Service Cards, last page.

F. J. Tompkins, Chief Design Engineer (right), Bernard Anik, Mechanical Engineer (left rear), Singmaster & Breyer, N. Y. C. Foreground, Michael De Piano, Cooper Alloy Corp.

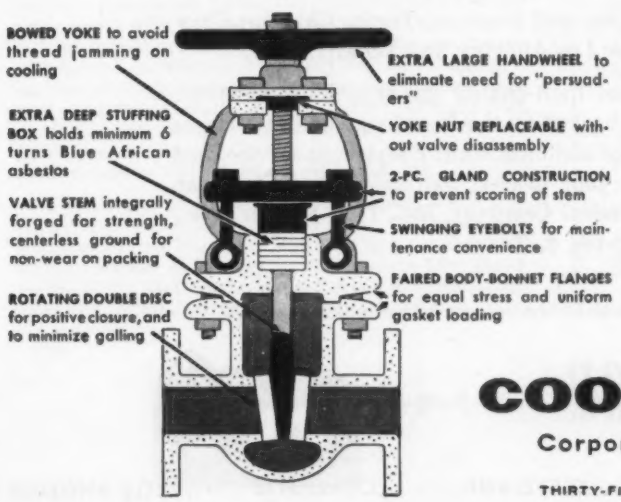
TOMPKINS and ANIK of SINGMASTER & BREYER

tell why they build Cooper Alloy stainless valves into their basic plant designs

Q. Gentlemen, precisely why do you buy Cooper Alloy valves?

FJT—With me, dependability is the main reason. My major concern is overall plant design, and frankly I don't have time to worry about every equipment detail. As specialists in designing and building "first-of-its-kind" processing plants, we need valves we can count on, and can "build in" as part of our original design. Cooper Alloy valves, we've found, fill that bill.

BA—From my point of view as a mechanical engineer, it's the Cooper Alloy valve *design* that appeals to *me*. It has extra features, like the extra-large handwheel, unique square compression of packing, bowed yoke, integrally forged stem, and others, all of which make for less maintenance and longer, more economical valve life.


BOWED YOKE to avoid thread jamming on cooling
EXTRA DEEP STUFFING BOX holds minimum 6 turns Blue African asbestos
VALVE STEM integrally forged for strength, centerless ground for non-wear on packing
ROTATING DOUBLE DISC for positive closure, and to minimize galling
EXTRA LARGE HANDWHEEL to eliminate need for "persuaders"
YOKE NUT REPLACEABLE without valve disassembly
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The Cooper Alloy valve is not an adaptation of earlier brass and iron patterns. Cooper Alloy, with over 35 years of experience in handling stainless steel, created a valve *designed to be cast in stainless!* **Check the Special Design Features shown at left.**

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Corporation • Hillside, New Jersey

VALVE & FITTING DIVISION

THIRTY-FIVE YEARS OF STAINLESS STEEL PIONEERING

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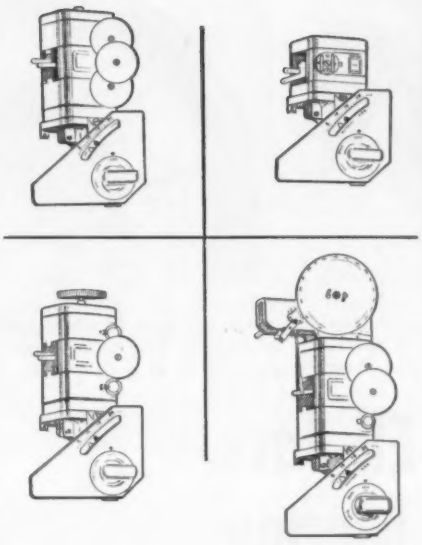

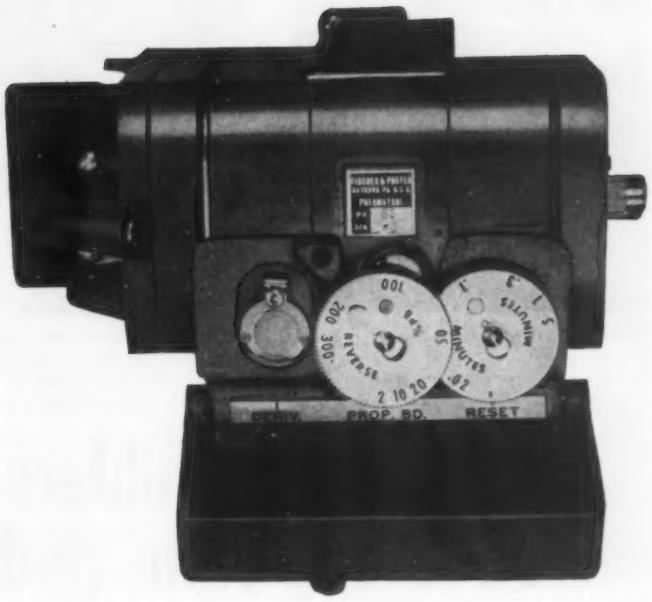

NOW . . . the P-4 controller is better than ever!

Back from a thorough redesign, the P-4 has more to offer than ever before. All the advantages proved in years of actual use have been retained . . . and more have been added. Chief among the improvements resulting from this complete re-evaluation are:

- Even *lower* steady state air consumption—and increased amplifying relay capacity
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- Greater independence from dirty air supply
- Easily accessible external alignment adjustments
- Improved frequency response characteristics
- Greater flexibility—new "Universal" design provides 2-50% proportional action, on-off controller action, 2-100% differential gap action—in *one controller!*

Brilliant instrument design has permitted all these improvements with no change in bellows construction or motion balance principle of operation. In-case models still feature completely integrated *in-the-case* accessories, free of troublesome links or complex external members. And they can still be mounted left or right with equal ease, permitting two to a single case if desired. Of course, a complete line of plug-in models for use with miniature instruments is still available.

If you'd like to investigate the renewed P-4B controller first hand, call in the Fischer & Porter field engineer serving you . . . or write for new Catalog 53P-4000 to Fischer & Porter Co., 1017 County Line Road, Hatboro, Pa. In Canada, write Fischer & Porter (Canada) Ltd., 2700 Jane Street, Toronto, Ontario.

PERFORMANCE SPECIFICATIONS • SERIES 53P—P-4B CONTROLLERS

Output pressure—*3 to 15 or 3 to 18 psig*

Set point and process pressures for field or plug-in models—*3 to 15 psig*

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Temperature limit—*225 F*

Supply pressure—*17 to 22 psig*

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Derivative gain—*approximately 12*

Field mounting manifold cut-off valve—*air to open*

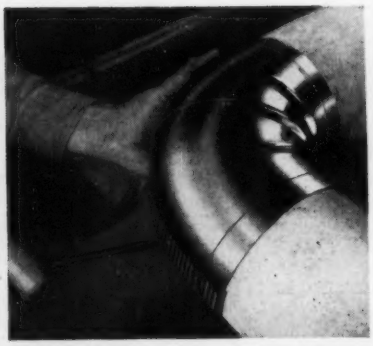
Steady state air consumption—*0.08 scfm*

	In Case Controllers	Plug-In And Field Mounted
On-off	53PR 4101	
"Universal" controller; 2-50% proportional, on-off, and 2-100% differential gap	53PR 4241	53PN 4240
Proportional only	53PR 4301	53PN 4300
Proportional plus fast derivative	53PR 4411	53PN 4410
Proportional plus slow derivative	53PR 4421	53PN 4420
Proportional plus fast reset	53PR 4511	53PN 4510
Proportional plus slow reset	53PR 4521	53PN 4520
Proportional plus fast derivative plus fast reset	53PR 4611	53PN 4610
Proportional plus fast derivative plus slow reset	53PR 4631	53PN 4630
Proportional plus slow derivative plus slow reset	53PR 4621	53PN 4620
Ratio—Proportional plus fast reset	53PP 4511	

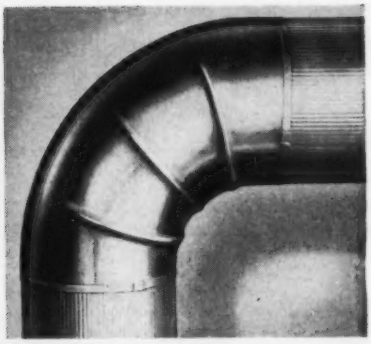
FISCHER & PORTER CO.
Complete Process Instrumentation

For more data on advertised products, use Readers' Service Cards, last page.

9:00 A.M. Workman places two halves of Ell-Jac over insulated elbow. Halves of Ell-Jac are held in place with wire while holes are drilled for sheet metal screws.



9:04 A.M. Screws are quickly inserted to hold Ell-Jac snugly and permanently in place. Childers Aluminum Ell-Jacs come in 23 standard sizes for both 90° and 45° long radius elbows.



9:06 A.M. Ell-Jac completely installed. When straight line aluminum weather-proof jacketing is added, lines have complete, maintenance-free protection for all costly insulation.

How New Childers Ell-Jacs Save You Time and Money

Revolutionary new Childers Ell-Jacs go on fast and easy . . . fit perfectly . . . cut installation costs . . . never need painting . . . and, used with Childers Jacketing, give your insulated lines that well-dressed look from end to end.

Now, aluminum elbows are made in a wide range of sizes by America's leading manufacturer of aluminum jacketing. Childers Aluminum Ell-Jacs are available for quick, easy application to protect costly elbow insulation.

Childers Ell-Jacs are two-piece, deep drawn from .020" aluminum, #3003 alloy. They are precision-formed for long-radius elbows and come in 23 sizes for both 90° and 45° ells.

Childers Ell-Jacs, together with Childers Jacketing, now let you install maintenance-free aluminum over every square foot of your valuable insulation. You protect *all* of your insulation investment at lowest cost. You get the bonus of a better looking plant and easier housekeeping.

Positive weather-proofing with Childers Jacketing is assured by exclusive Childers Lap-Seal (Patents Pending). You're sure of getting proper lap without waste. You save labor, too.

Factory attached moisture barrier protects both Childers Jacketing and Childers Ell-Jacs against corrosion that could otherwise damage the underneath side of the aluminum. Its slight extra cost is more than offset by savings in application labor.

You also get greater strength and greater protection because Childers Jacketing is cross-crimped. Cross-crimping increases the vertical strength and rigidity of a .016" sheet to that of a plain .024" sheet.

It's easy to install Childers Jacketing. All you need are pliers and screwdriver, plus inexpensive strapping. Two men can do the job. Jacketing can be removed for inspection of the lines, then reapplied without waste.

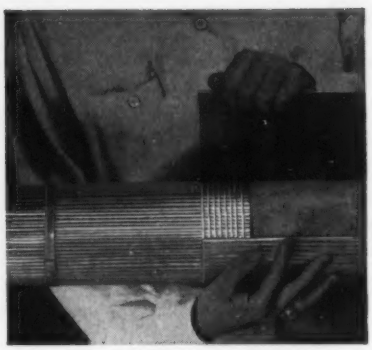
First cost is less for Childers Jacketing than for any other permanent type weatherproofing—even less than some temporary coverings.

You end maintenance worries, too, by using Childers Aluminum Weather-proof Jacketing and Ell-Jacs. Aluminum *keeps* its new look; needs no expensive periodic repainting.

Why not benefit from Childers world-wide experience when you buy insulation for your lines, towers, vessels, and tanks? More than 2,000 petroleum refining, petro-chemical, and chemical plants will endorse your decision. Childers Engineering Representatives, located in 27 major industrial centers, give professional advice on insulation jacketing.

For a free sample of Childers Aluminum Weather-Proof Jacketing, with engineering data on how to safeguard your insulation, write Childers Manufacturing Company, Dept. PR-40, P. O. Box 7467, Houston 8, Texas.

See our ad in Sweet's Industrial Construction File, Chemical Engineering Catalog and Refinery Catalog.



EXCLUSIVE LAP-SEAL, available at no extra cost, is a series of 8 ribs rolled into the underlapping edge of the jacketing, providing an automatic measure of the 2" circumferential lap. Proper lap is assured without waste. Labor is saved. Where desired, a positive weather seal is easily made with Lap-Seal and a mastic.

DEEP CORRUGATED Childers Jacketing in 1¼" and 2½" corrugations is recommended for permanent protection and improved appearance of insulated towers, vessels, tanks. Deep Corrugated Jacketing with factory-attached moisture barrier is another product available only from Childers. (Adv.)

TURBO-MIXER has the solution to your mixer problems

Mixing problems? Consult Turbo for the solution. We offer equipment known everywhere for quality; fast convenient service; complete laboratory facilities staffed by engineers who will be glad to work with you. For a high-production, low-maintenance mixer program, call on TURBO.

A *No worry about quality with modern Turbo-Mixer facilities like these at Sharon, Pa. All the capacity you require, in Turbo-Mixer Class "A" shops capable of handling mixers from 2' to 20' diameter—¼ to 500 H.P.*

B *For your special problems or the development of new designs, all the technical knowledge and experience of Turbo-Mixer research men is yours to use. Here we have complete facilities for laboratory and pilot-testing to solve your mixer problems.*

C *Turbo-Mixer service is fast and efficient...like this new office at Compton, California, Turbo-Mixer has 26 sales and service offices throughout the United States and Canada—plus Erection Service Departments strategically located to serve you.*

D Evidence? *The bevel gear Turbo-Mixer drivehead in this picture is still in A-1 operating condition after more than 100,000 hours of continuous service with only normal maintenance. It's just one of hundreds of equally satisfactory Turbo-Mixer products serving today's tough industrial requirements.*

TURBO-MIXER GENERAL AMERICAN TRADE MARK

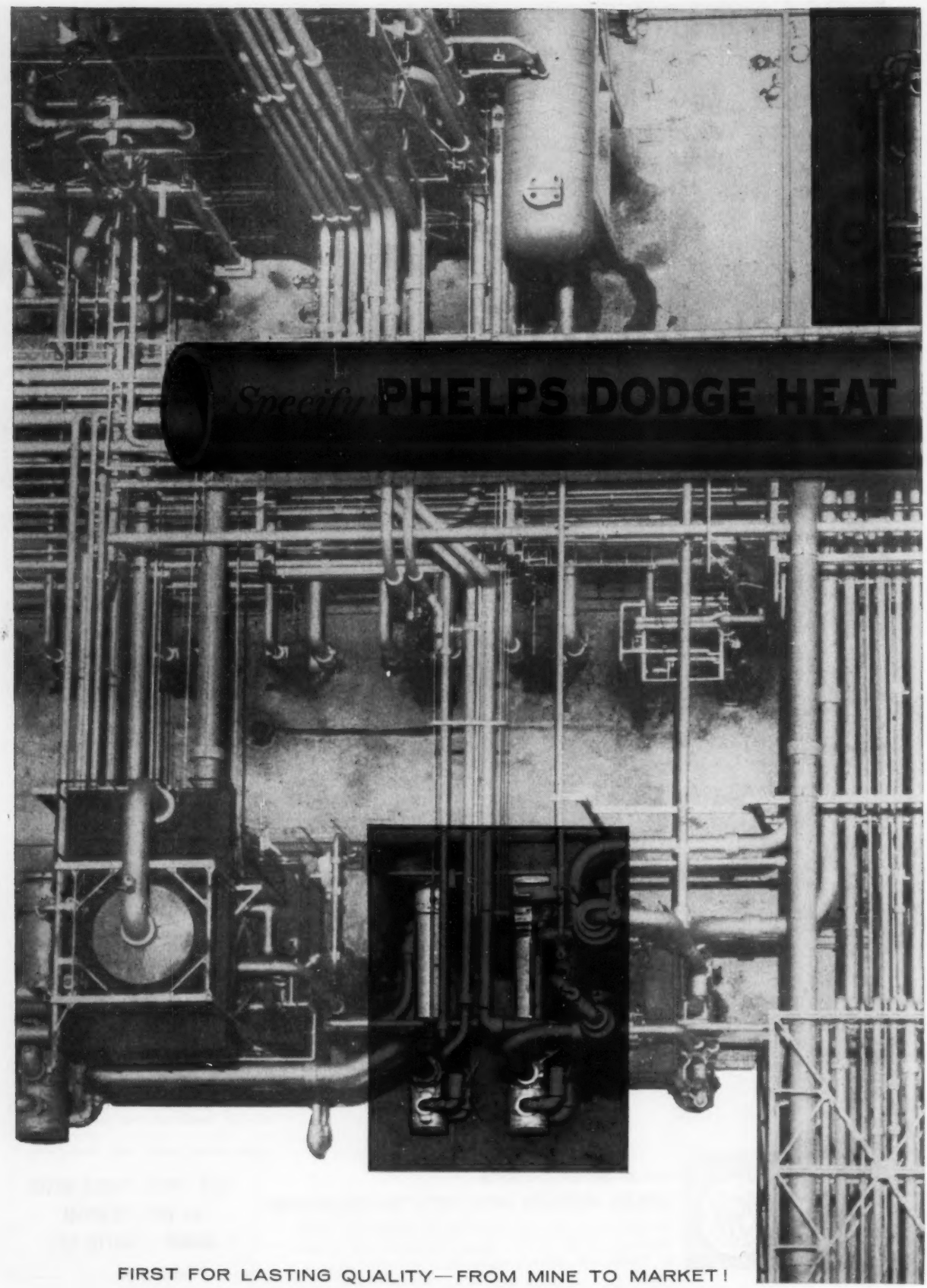
TURBO-MIXER DIVISION

GENERAL AMERICAN TRANSPORTATION CORPORATION

SALES OFFICE: 380 MADISON AVENUE, NEW YORK 17, NEW YORK. General Offices: 135 S. La Salle St., Chicago 90, Illinois. Offices in all principal cities.

DON'T MISS TURBO-MIXER AT THE CHEMICAL SHOW...BOOTH 446

For more data on advertised products, use Readers' Service Cards, last page.



FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!

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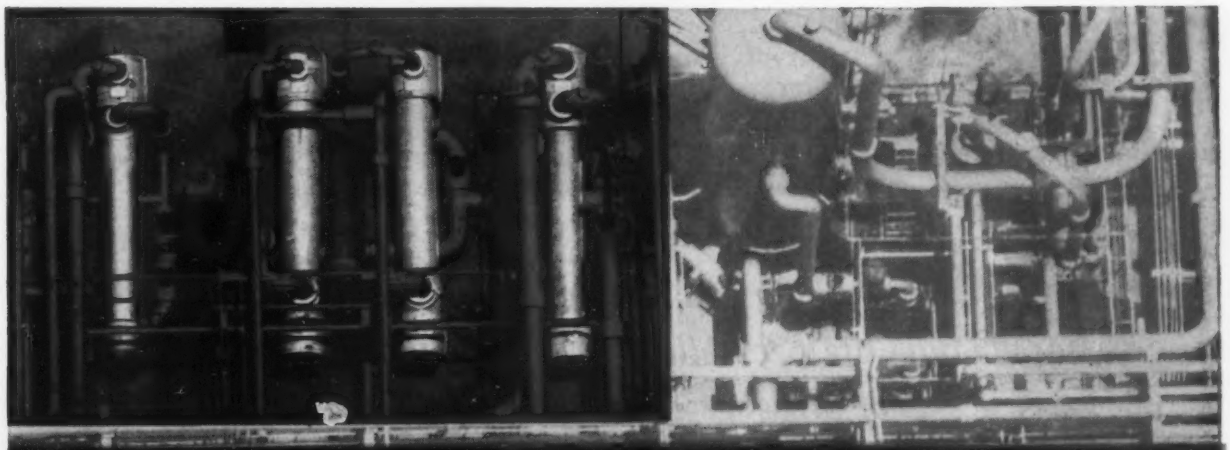
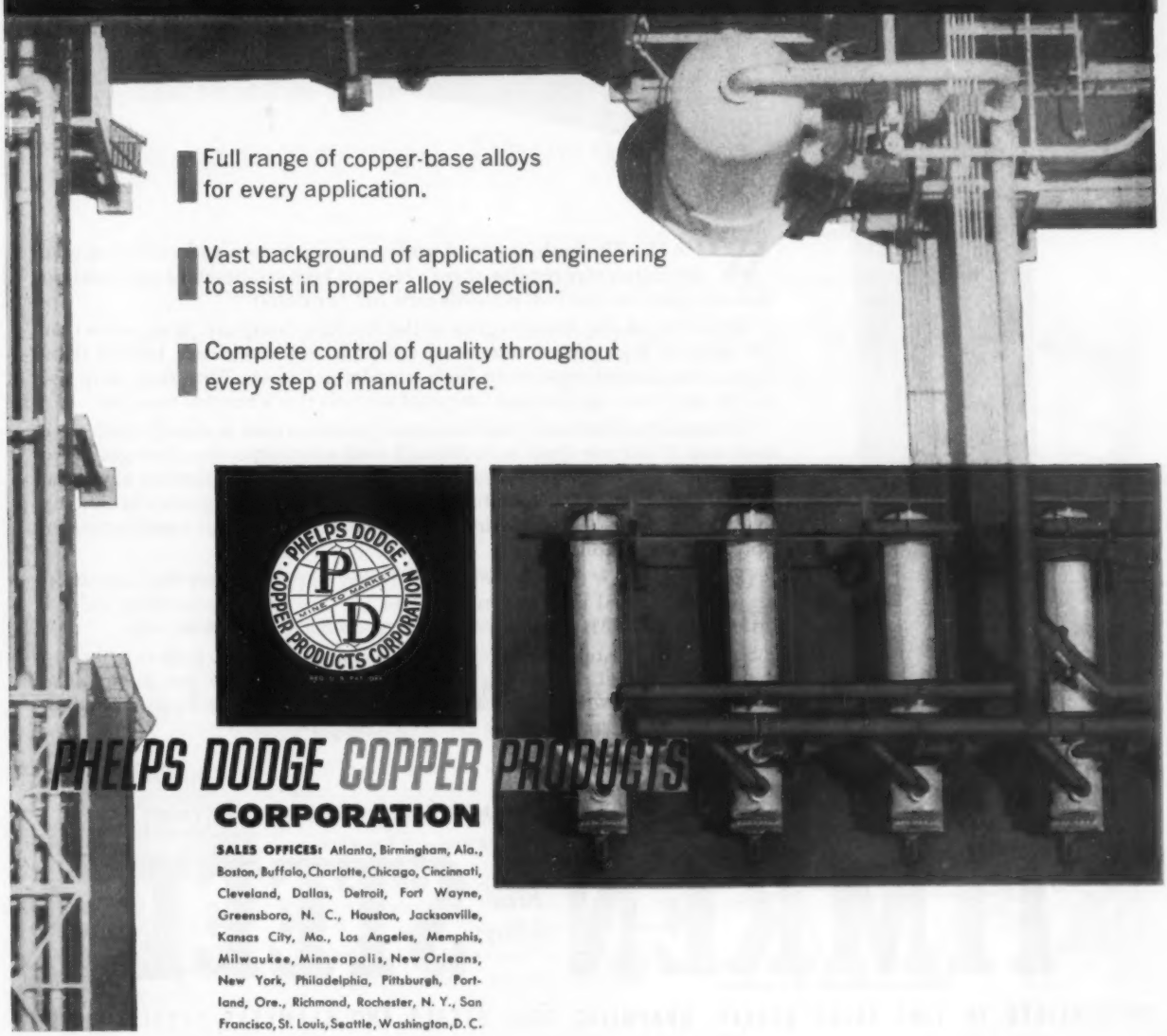


EXCHANGER TUBES *for Longer Service!*

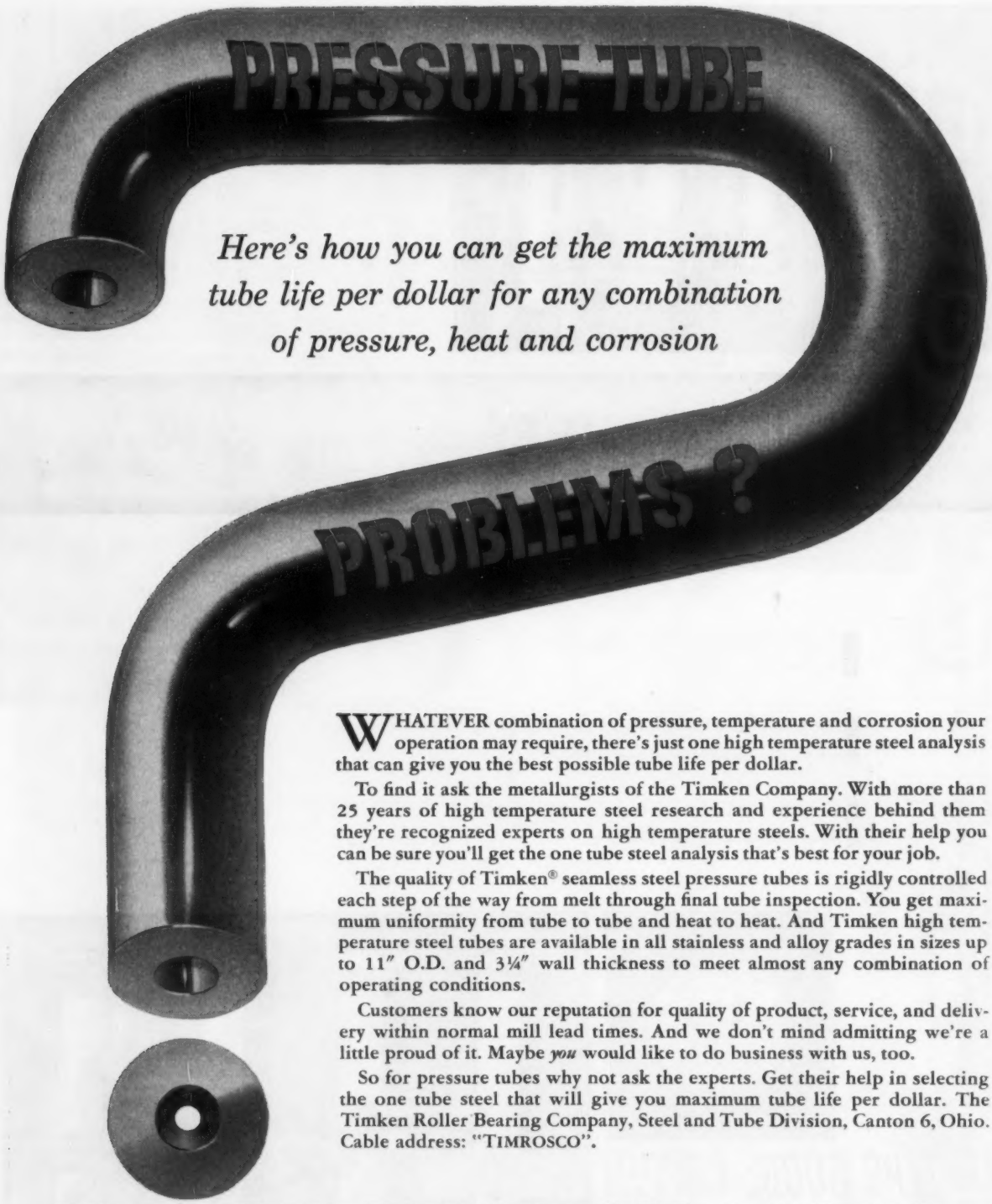


- Full range of copper-base alloys for every application.
- Vast background of application engineering to assist in proper alloy selection.
- Complete control of quality throughout every step of manufacture.

PHELPS DODGE COPPER PRODUCTS CORPORATION

SALES OFFICES: Atlanta, Birmingham, Ala., Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Fort Wayne, Greensboro, N. C., Houston, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.

For more data on advertised products, use Readers' Service Cards, last page.



Here's how you can get the maximum tube life per dollar for any combination of pressure, heat and corrosion

WHATEVER combination of pressure, temperature and corrosion your operation may require, there's just one high temperature steel analysis that can give you the best possible tube life per dollar.

To find it ask the metallurgists of the Timken Company. With more than 25 years of high temperature steel research and experience behind them they're recognized experts on high temperature steels. With their help you can be sure you'll get the one tube steel analysis that's best for your job.

The quality of Timken® seamless steel pressure tubes is rigidly controlled each step of the way from melt through final tube inspection. You get maximum uniformity from tube to tube and heat to heat. And Timken high temperature steel tubes are available in all stainless and alloy grades in sizes up to 11″ O.D. and 3¼″ wall thickness to meet almost any combination of operating conditions.

Customers know our reputation for quality of product, service, and delivery within normal mill lead times. And we don't mind admitting we're a little proud of it. Maybe *you* would like to do business with us, too.

So for pressure tubes why not ask the experts. Get their help in selecting the one tube steel that will give you maximum tube life per dollar. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

See the next Timken Televent hour, "The Innocent Years" over NBC-TV, Thursday night, November 21st.

TIMKEN *Fine Alloy* STEEL

TRADE-MARK REG. U. S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

HOW SOLVENT EXTRACTION WITH QO® FURFURAL

Increases Cracker Through-Put
Increases Gasoline Yield
Lowers Unit Costs
Improves Products

QO Furfural sharply reduces many trouble-makers encountered in cat cracking. These include the refractory or carbon forming materials that overload the coke burning facilities of the unit and the heavy metal complexes that are notorious catalyst poisoners. Sulfur and nitrogen compounds are reduced substantially. Removal of these materials means increased through-put, increased gasoline yield, lower unit costs, and better product quality.

Three Uses for One Unit

One furfural unit can refine lube oil, cycle stock or virgin gas oil as demand dictates. In all three operations, QO Furfural offers excellent selectivity, ease of recovery, low cost, ready availability and freedom from excessive toxicity.

For more information, write

The Quaker Oats Company
CHEMICALS DEPARTMENT

340Z The Merchandise Mart, **Chicago 54, Illinois**
Room 540Z, 120 Wall Street, **New York 5, New York**
Room 440Z, 48 S.E. Hawthorne Blvd., **Portland 14, Oregon**
In the United Kingdom: Imperial Chemical Industries, Ltd., Billingham, England
In Europe: Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands; Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France; A/S "Ota," Copenhagen, S. Denmark
In Australia: Swift & Company, Pty., Ltd., Sydney
In Japan: F. Kanematsu & Company, Ltd., Tokyo

The Quaker Oats Company — CHEMICALS — QO FURAN CHEMICALS — DEPARTMENT

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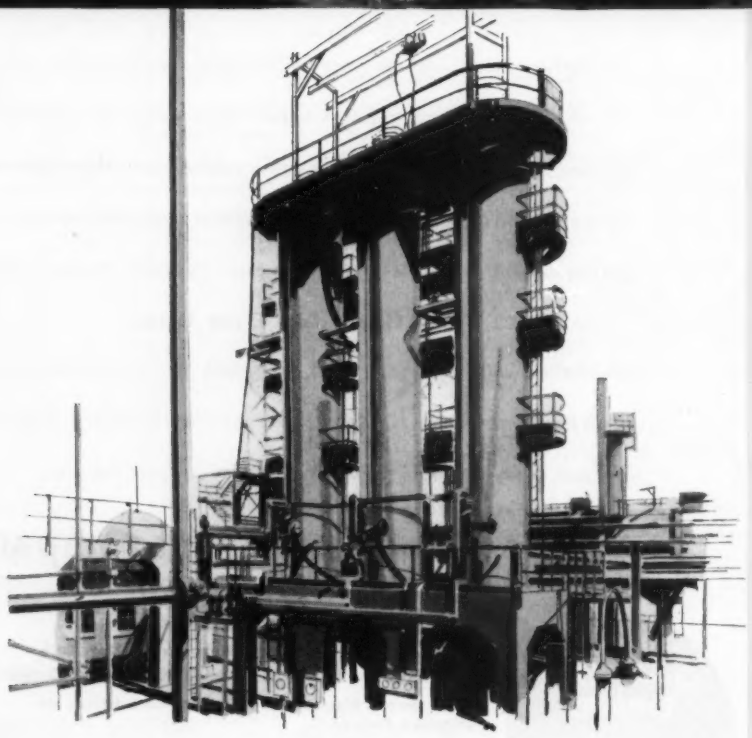
The idea that works best for you



More Than Forty Years Of Leadership In Petroleum Refining Technology

has meant a lot of work for us

We should know. For more than 40 years UOP has been developing ideas to improve petroleum refining technology. In that time we've had a whale of a lot of ideas. Very few of the successful ones come easy. Most have to be developed the hard way, through months, even years, of creating, trying, perfecting and proving. And the pay-off for our staff of scientists, technicians and engineers comes with the proving, when the idea has been perfected so that it can work well for you.

Once we're sure it is a practical, workable idea that will help make oil refining more efficient, more productive, more profitable, it doesn't go into limbo or on the shelf. It is made immediately available to all refiners regardless of the size or scope of their operation, anywhere in the free world. We think our obligation to the industry can only be fully answered through this policy —create the ideas, make them workable and put them right to work for the benefit of everyone.

UOP UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U. S. A.

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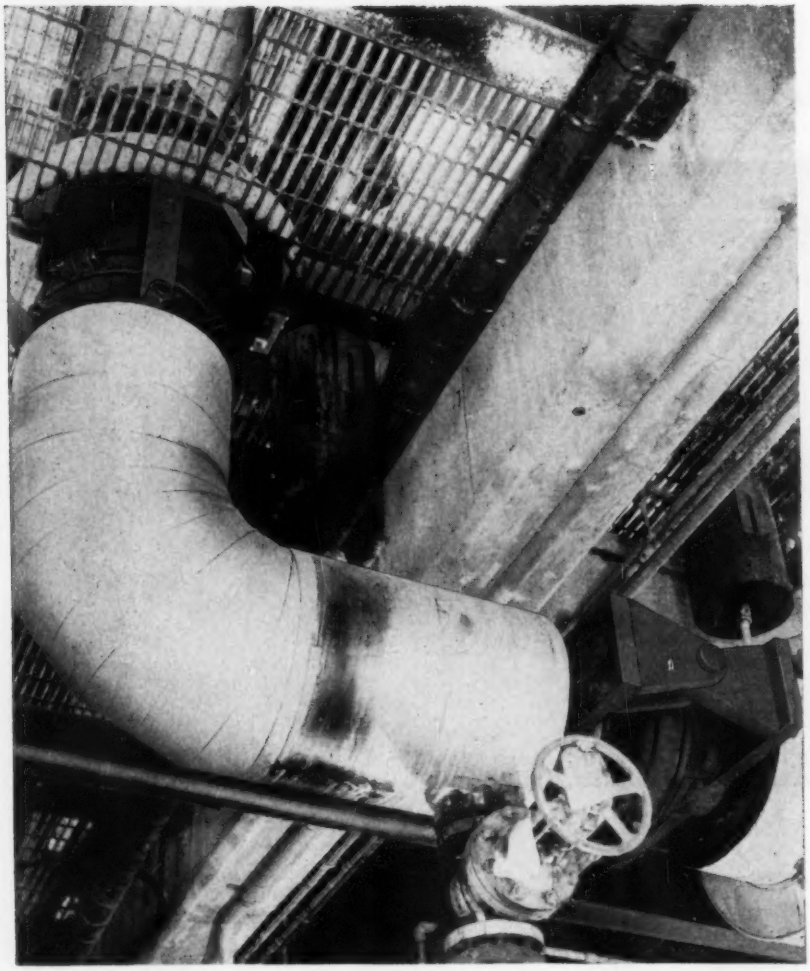

THIS IS WHAT ADSCO MEANS BY SPECIAL JOINTS

The photo shows a small but very important section of an insulated, spring-suspended 8″ pipe line in the new Moundsville, W. Va., plant of the National Aniline Division of Allied Chemical & Dye Corp. At the point shown, the line is subjected to complex stresses which are completely resolved and placed in balance by the ADSCO Gimbal Expansion Joint, upper left, and the ADSCO Hinge Expansion Joint, lower right.

In the Gimbal Joint, two sets of bars are pinned to the octagonal ring at 90° to each other. The other ends of the bars, still at 90° to each other, are pinned to the pipe leading into the joint. Running through the center of the ring, with a slight clearance, is a nipple connecting two expansion elements. This gimbal arrangement permits the joint to absorb 6° of angular movement from two different directions: the left and right motion of the horizontal part of the ell and similar motion from other unseen upper horizontal piping at 90° to the plane of the lower piping.

A partner to the Gimbal Joint and an indispensable part of this piping system is the Hinge Joint shown lower right. This absorbs the angular rotation of the ell caused by the expansion and contraction of the vertical piping.

There are so many motions involved in this section that, under certain conditions, the octagonal ring of the Gimbal Joint could describe a circle. Yet ADSCO and National Aniline engineers were able to identify all the motions and absorb them economically and efficiently by the Gimbal and Hinge Joints.

ADSCO designs and manufactures many types of both standard and special joints for many purposes. Consult ADSCO on any piping problem.

ADSCO DIVISION
YUBA CONSOLIDATED INDUSTRIES, INC.
20 MILBURN ST. BUFFALO 12, N. Y.

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NEW EMS SERIES
Magnetic,
across-the-line
Motor Starters

INDUSTRIAL CONTROL PYLETS®

EXPLOSION-PROOF AND DUST-TIGHT

FOR HAZARDOUS LOCATIONS

SECOND TO NONE FOR...SAFETY AND ECONOMY...LONG SERVICE LIFE

New ECB Series Circuit Breakers

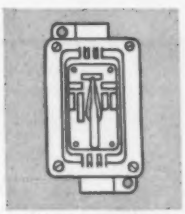
NEW

CORROSION-PROOF COVER JOINT:

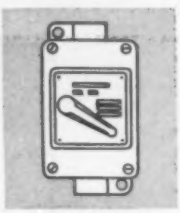
The metal to metal joints of all explosion-proof Pylets, both the ground joint types and the threaded joint types, are cadmium plated to maintain the integrity of the flame arresting path against corrosion. Only cadmium plate can provide this valuable protection on ferrous alloy castings.

The new EMS motor starters, ECM combination motor starters and ECB circuit breakers have cadmium plated, ground cover joints plus the following features:

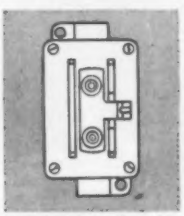
- COMPACT RECTANGULAR SHAPE
- HINGE SUPPORTED COVER
- RAIN-TIGHT PROTECTION
- COMPLETE ACCESSIBILITY FROM FRONT
- MINIMUM BENDING OF CONDUCTORS
- TAPERED TAPPED HUBS



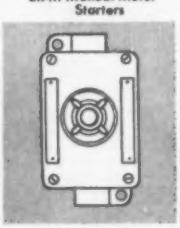
ER-SS Selector Switches



ER-M Manual Motor Starters



ERC Push Button Stations



ERP Pilot Lights

SINCE 1897

Sold Nationally Through Authorized Distributors. Write for Literature.

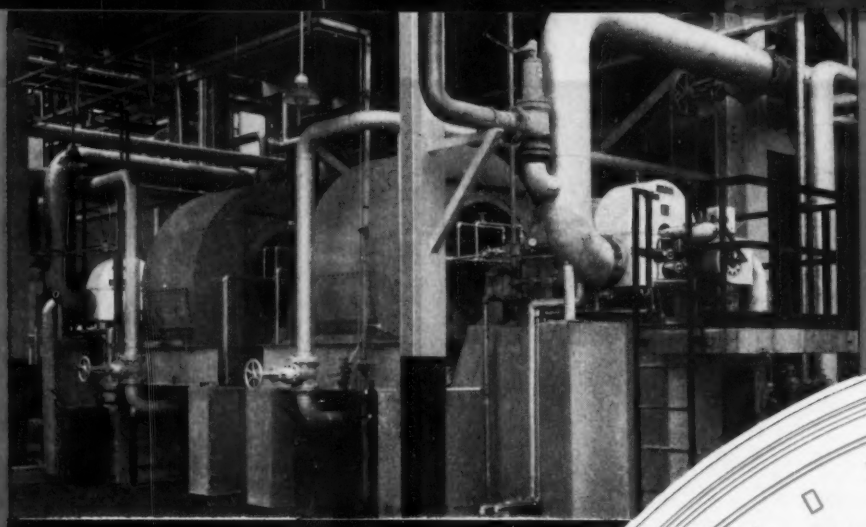
THE PYLE-NATIONAL COMPANY

WHERE QUALITY IS TRADITIONAL

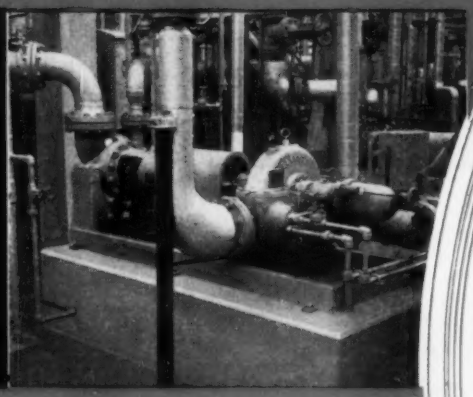
North Kostner Avenue, Chicago 51, Illinois

BRANCH OFFICES AND AGENTS IN PRINCIPAL CITIES OF THE U.S. AND CANADA • CANADIAN AGENT: THE HOLDEN CO., LTD. MONTREAL • RAILROAD EXPORT DEPARTMENT: INTERNATIONAL RAILWAY SUPPLY CO., 30 CHURCH ST., NEW YORK 7, N.Y. • INDUSTRIAL EXPORT DEPARTMENT: ROCKE INTERNATIONAL CORP., 13 E. 40TH ST., NEW YORK 16, N.Y.

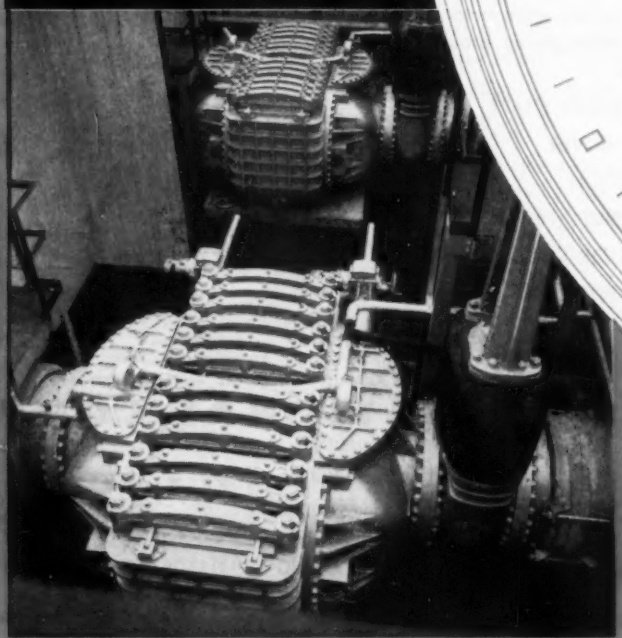
CONDUIT FITTINGS • PLUGS AND RECEPTACLES • LIGHTING FIXTURES • FLOODLIGHTS



ELLIOTT TURBINES which drive forced-draft fans in one of the many boiler plants of the Tidewater Delaware refinery.



TURBINES throughout the refinery are Elliott-engineered machines. Here one of them drives an oil pump.

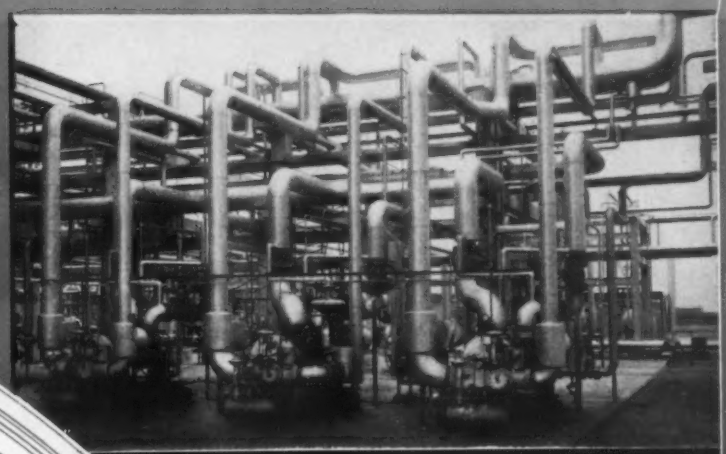


TWIN STRAINERS include ten giants like these 36-in. Elliott units with motor-operated valves.

'round-the-clock dependability

ELLIOTT PRODUCTS

serve Tidewater's Delaware Refinery



ELLIOTT STEAM TURBINES drive all sorts of oil pumps in many locations. Here is a line of three.

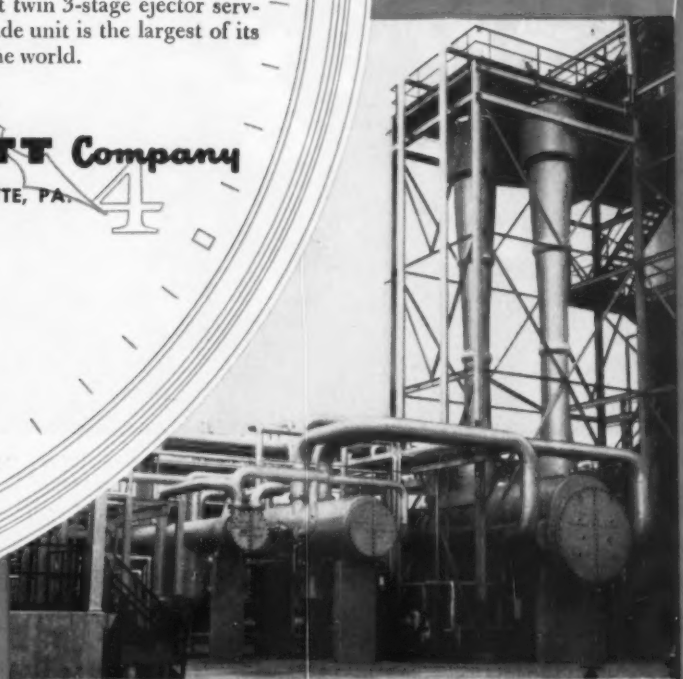
The 130,000-barrel-per-day Tidewater Oil Company refinery in Delaware is "on stream" round-the-clock, and continuous and dependable performance of its equipment is vitally important. Elliott products are excellently suited to this type of operation because they are designed and built for long-time, non-stop, trouble-free service.

Elliott steam turbines, ranging in size from 5 to 935 hp, drive pumps, fans, and compressors. All the water serving this refinery is put through Elliott twin strainers, 3 in. to 36 in., located in pits in various locations. The Elliott twin 3-stage ejector serving the vacuum crude unit is the largest of its type anywhere in the world.

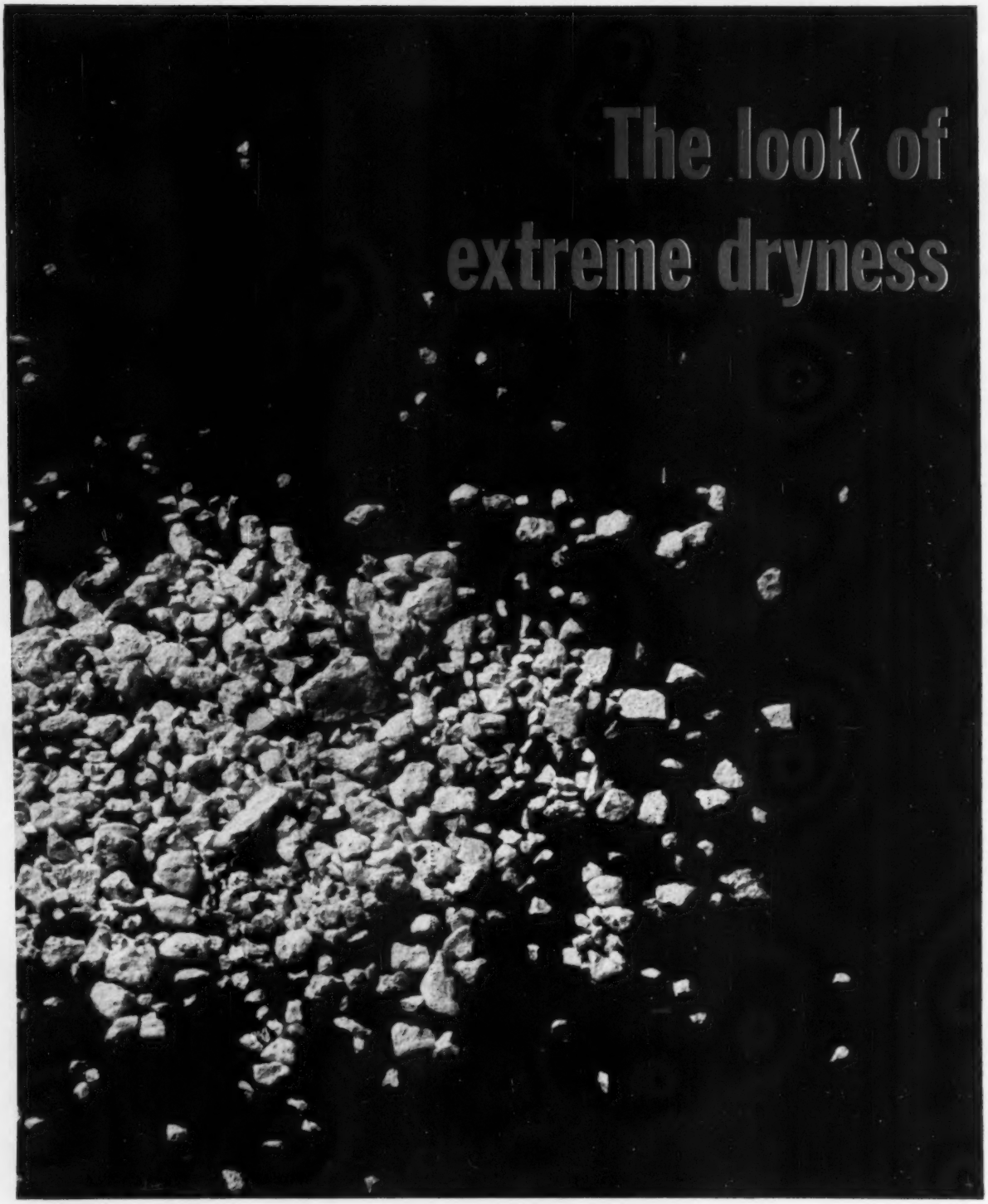
ELLIOTT Company

JEANNETTE, PA.

TWIN STRAINERS also include smaller sizes like these two 16-in. motor-driven and a 6-in. hand-operated twin strainer.



ELLIOTT TWIN THREE-STAGE EJECTOR, designed to maintain a suction pressure of 5 mm Hg absolute, serves the world's largest vacuum crude distillation unit. Vertical first stages have 60-in. diameter inlet and are 40 ft long. Surface-type inter- and aftercondensers are shown.



for gases, liquids & vapors—Looking for an efficient, *economical* adsorbent to obtain extreme dryness in gases, liquids or vapors? Then look to ALCOA® Activated Alumina, the oldest, most thoroughly proved commercial adsorbent available.

ALCOA Activated Alumina dries to lower dew points (minus 100°F and lower) than any other commercial desiccant. Nontoxic, noncorrosive and chemically inert, it relieves you of contamination worries and eliminates many serious maintenance problems. Because it remains fully effective through almost unlimited saturation-reactivation cycles, it insures lowest possible dehydration costs.

Let ALCOA help you solve your dehydration problems. Get complete information today on the properties and performance of ALCOA Activated Alumina. Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 717-L Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA CHEMICALS

NEW!
"ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings

For more data on advertised products, use Readers' Service Cards, last page.

S & J GARDTROL® provides

Positive remote supervisory control of pump motors and valves

Two complete packaged remote control systems are now available for application to distant motor operated valves and electric pump motors. Gardtrol Valve and Pump Motor Monitors provide constant monitoring and positive, non-ambiguous indication of "on", "off", "open", "closed" and "stopped" conditions at remote stations. Both units feature simplified design—three components, a control unit, field unit and single wire transmission line provide efficient, economical controlling. Exclusive Gardtrol circuit utilizes the cyclically-reversing polarity of alternating current to effect both control and supervision over one wire. Distance is limited only by the resistance of the signal wire.

two packaged units

GARDTROL VALVE MONITOR
opens, closes or stops valves in any position

GARDTROL PUMP MOTOR MONITOR
indicates off, on, starts and stops motors

Call or write your nearest Shand and Jurs office for specifications and prices.

SHAND AND JURS CO.
8th and Carleton Streets, Berkeley, California

a subsidiary of General Precision Equipment Corporation

NEW YORK	TULSA	LOS ANGELES	HOUSTON	CHICAGO
110 E. 42nd St.	Thompson Bldg.	6399 Wilshire Blvd.	M & M Bldg.	10409 S. Western Ave.

REPRESENTATIVES

SEATTLE: Nebar Supply Company, 3000 Western Ave. **MONTREAL:** Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W. **TORONTO:** Lytle Engineering Specialties, Ltd., 69 Eglinton East. **VANCOUVER:** P. D. McLaren & Son, Ltd., 3277 Main St. **CALGARY:** P. D. McLaren & Son, Ltd., 510 - 9th Ave., W. **MEXICO, D. F.:** Dalma Comercial, S. A. **CARACAS:** Sinclair Spence, C. A., Edificio Galipan. **ENGLAND:** Whessoe, Ltd., Sales: 25 Victoria St., London S. W. 1 Whessoe, Ltd., Works: Darlington, County Durham

4414

Get the unique combination of tubing properties your layout requires—plus!

Type 310 stainless steel retort (25% Chrome—20% Nickel) fabricated and machined at Acipco. Completed retort is 27'-6" long and weighs 12,500 pounds.

Versatile ACIPCO

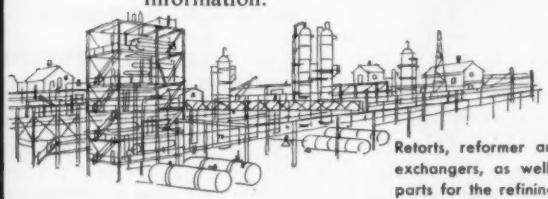
Centrifugally Spun Tubing

offers special advantages when your application requires an unusual combination of properties in the tubular parts of your layout.

Any required degree of heat resistance . . . corrosion resistance . . . abrasion resistance . . . strength — or any combination of physical, chemical or metallurgical properties — can be produced in special steel or alloy iron analyses at ACIPCO.

"Custom spun" in a wide range of ID's and OD's, ACIPCO tubes can be furnished as cast, rough or finished machined, or *completely fabricated* to your exact specifications in large or small quantities.

Investigate the plus advantages of ACIPCO's "one-source — from tube to finished part" service. Call or write the ACIPCO distributor nearest you, or write direct, for full information.



Retorts, reformer and furnace tubes, heat exchangers, as well as hundreds of other parts for the refining and petrochemical industries have been fabricated from Acipco centrifugally spun steel and alloy iron tubes.

SIZE RANGE: Lengths up to 410″ to meet modern requirements have been produced. OD's from 2.25″ to 50″; wall thicknesses from .25″ to 4″.
ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steels; plain carbon grades and special non-standard analyses.
FURNISHED: As cast, rough machined, or finish machined, including honing.

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Peter A. Frasse and Co., Inc.
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New York 13, New York

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J. M. Tull Metal & Supply Co.
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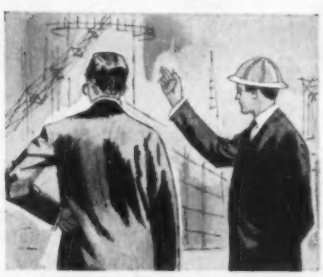
ACIPCO
Special Products Division
BIRMINGHAM 2, ALABAMA

CONTRACT ENGINEERING with a difference

from initial negotiations . . . to "on stream" you deal with Badger principals

You first make contact with Badger through a Key Man as he works with you and your engineering staff in pinpointing your processing and economic problems.

The Key Man, acting in your behalf, takes your problem to Badger engineering specialists for preliminary study and evaluation.



With recommendations approved and construction underway, the Badger Key Man is still on the spot coordinating activities. He remains in charge until your project is complete.

AN engineering project handled by Badger is a group effort involving many highly developed skills. And from first contact until the project is complete these experienced specialists are headed by a Badger Key Man. More than just a sales engineer, he is always a Badger principal — always the Key Man in the execution of the project.

This sensible operating policy, which channels project liaison, coordination and administration through a company principal, is important to you and your project. You will find that most policy level decisions can be made on the spot as situations require. Further, the Key Man's depth of experience means you deal with an executive-engineer who talks your language — knows your problems and how to find their solutions.

Many clients say Key Man Policy is the Badger difference that makes the difference. Wouldn't it be wise to inquire how it could serve to make your projects more successful?

BADGER

MANUFACTURING COMPANY

230 Bent St., Cambridge, Mass.
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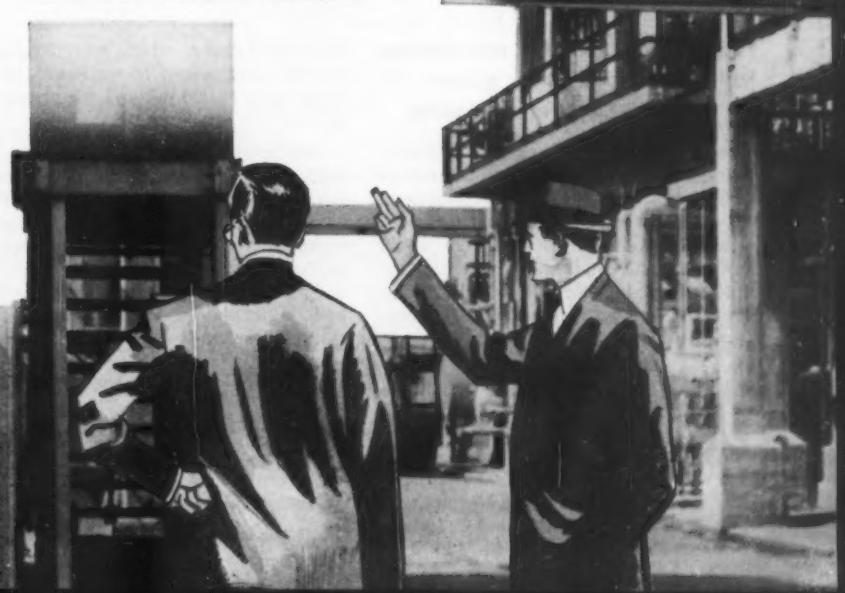
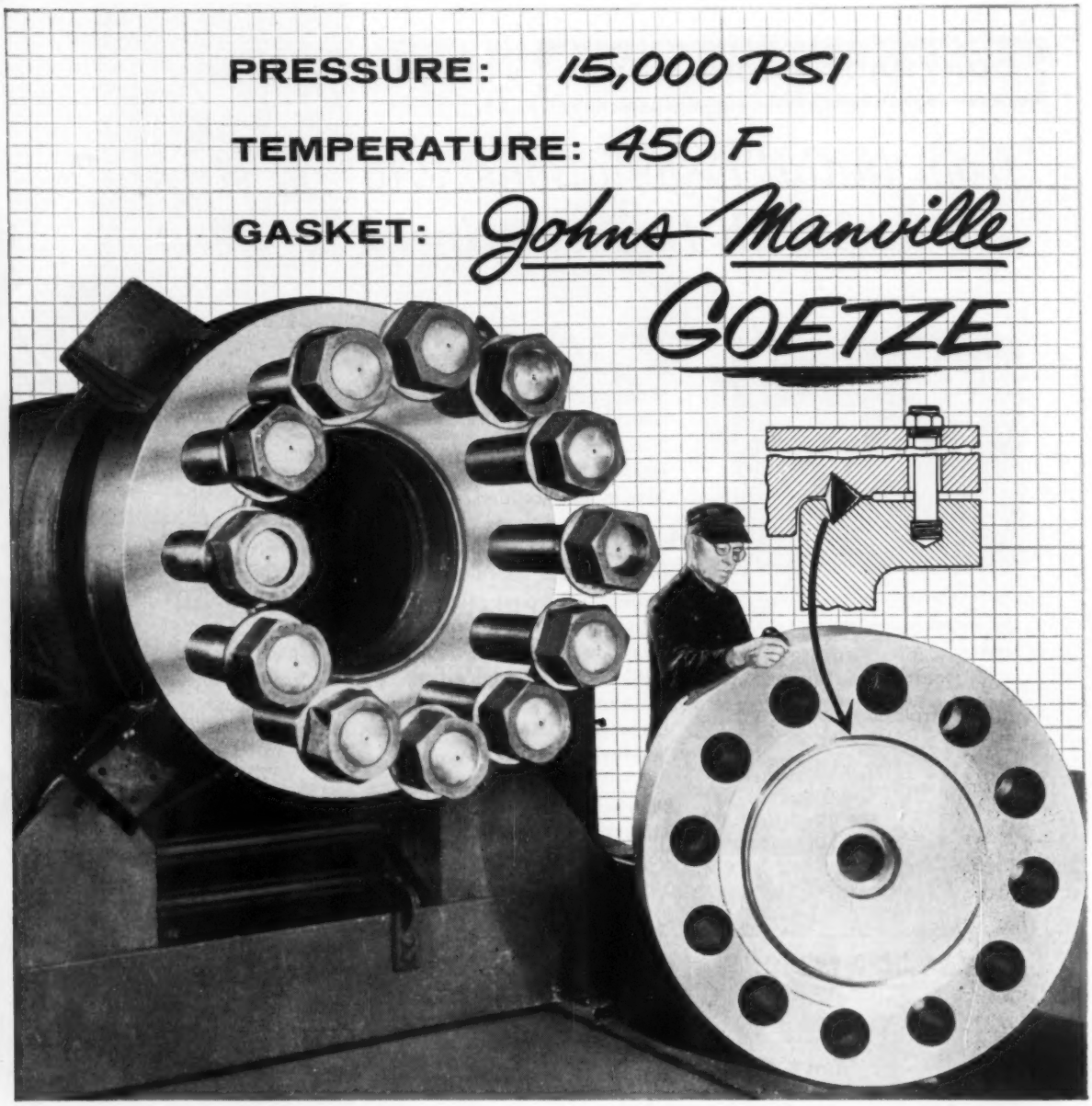
ENGINEERS • CONTRACTORS • DESIGNERS • MANUFACTURERS





How A. O. Smith maintains tight seals in giant "Multi-Layer" vessels

Today's tremendous pressures and temperatures have placed special demands on manufacturers of processing equipment. A. O. Smith has answered this need with a special type of "Multi-Layer" vessel construction. And Johns-Manville in turn has provided gaskets that assure tight seals under these exacting conditions. Typical of these is the delta type gasket, illustrated above, which was designed, for this application, to withstand pressures up to 15,000 psi. and temperatures to 500 F.

The development of special gaskets to meet special purposes has been the stock in trade of Johns-Manville's Goetze division for more than sixty-five years. Expert technicians possess a knowledge of metals and other factors related to gasket design and performance that is unmatched in the field. What's more, intensive specialization and modern production tooling provide substantial cost savings on J-M gaskets.

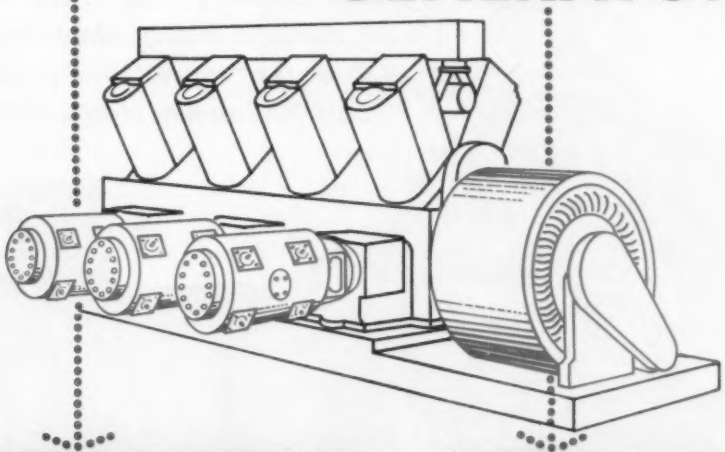
If you need gaskets for high pressure vessels for similar applications, send us a drawing or template for quotation. If you have a sealing problem of any kind, J-M technicians will work directly with your own engineers to develop new gaskets —or adapt existing styles—to meet your specific requirements. Write for further information to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit (Toronto), Ontario.

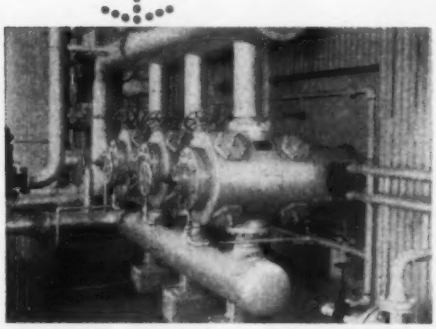
Johns-Manville PACKINGS & GASKETS

For more data on advertised products, use Readers' Service Cards, last page.

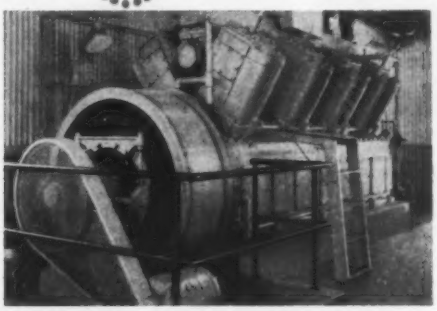
a COMPRESSOR in summer...

a GENERATOR in winter





Exterior view of compressor house at Reef Fields Gasoline Corp., Big Springs, Texas, showing compressor cylinders of the I-R gas-engine-compressor and generating unit beyond the firewall.



Interior view, showing the 275-kw generator on the I-R gas-engine-compressor and generating unit. Generator rotor provides proper flywheel effect when unit operates as compressor.

Double-Duty unit demonstrates versatility and smooth control of Ingersoll-Rand FOUR-CYCLE Gas-Engine Compressors

Why use two when one will do? The unusual combination shown above does two completely different jobs for the Reef Fields Gasoline Corp. It consists basically of an Ingersoll-Rand SVG gas-engine-compressor with an A-C generator in place of the usual flywheel.

In the summer months, this 440-hp unit is used as a refrigeration compressor. Its compressor cylinders boost propane gas to 200 psi, for use as a coolant in butane and propane recovery.

In winter when the refrigeration is not needed, the unit is put on full generator service. Its 275-kw generator alternates with four regular Ingersoll-Rand PVG gas-engine-generator units.

This double-duty application was made possible by the stability and smooth control inherent in every I-R 4-cycle, V-angle gas-engine compressor. The 4-cycle smoothness, so essential for A-C generator drive, also is important for compressor service: I-R units operate equally well from full load to no load and from full speed to half speed.

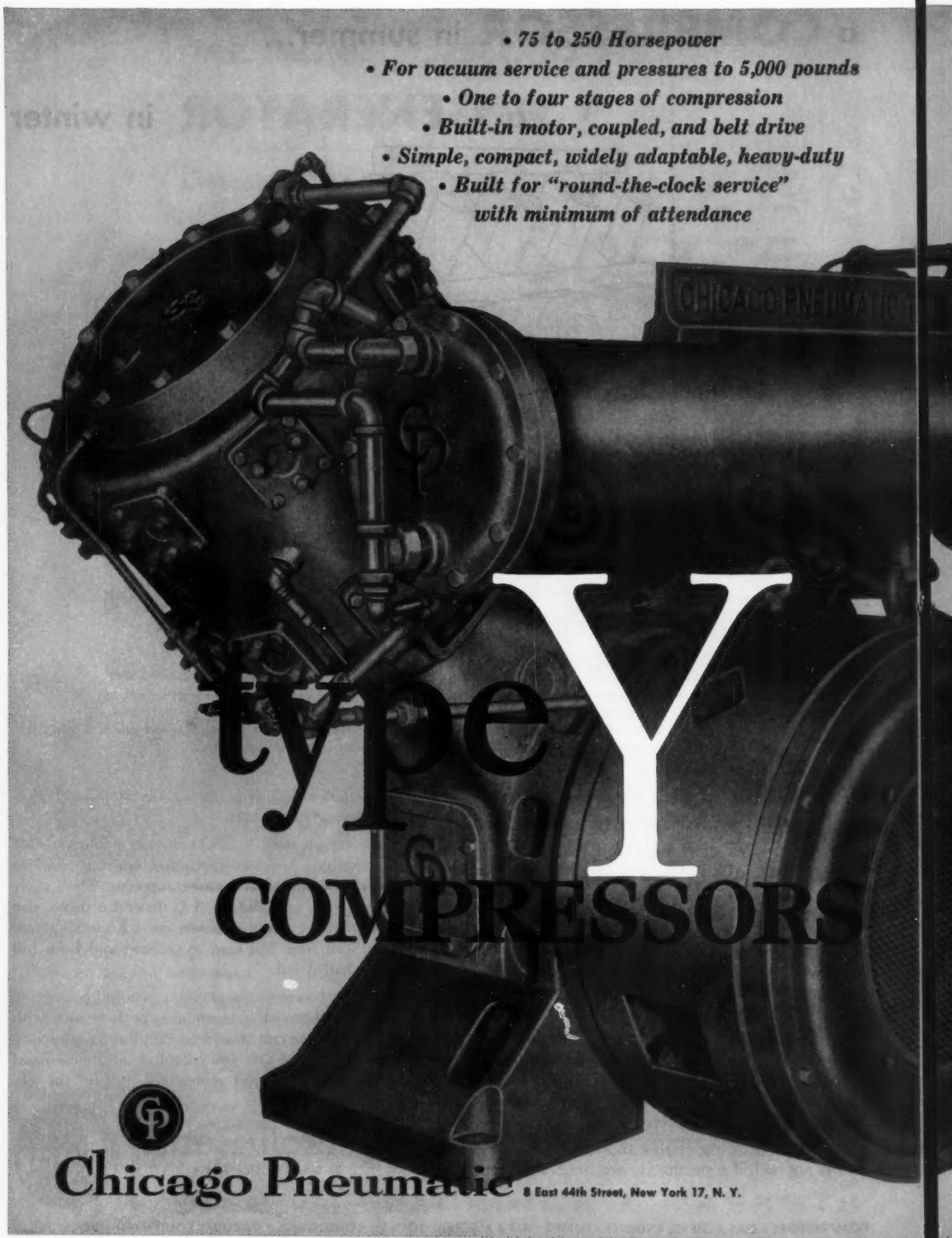
Whether you need *compression*, *generation*, or *both*, you're sure of smooth, dependable performance with an I-R gas-engine unit. Your Ingersoll-Rand representative will be glad to give you complete information and help you select the most economical unit for the job.

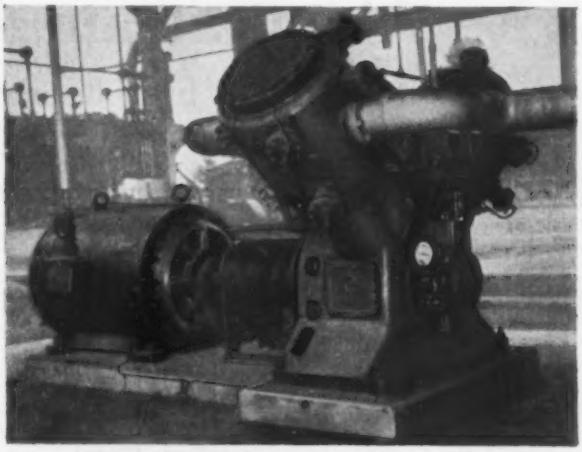
Ingersoll-Rand

6-688 11 Broadway, New York 4, N.Y.

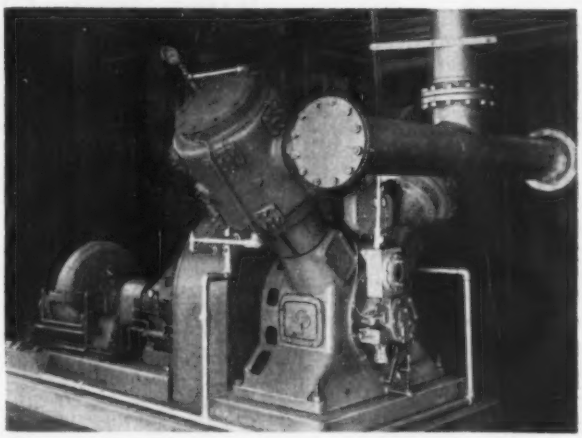
4-CYCLE

COMPRESSORS • GAS & DIESEL ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS

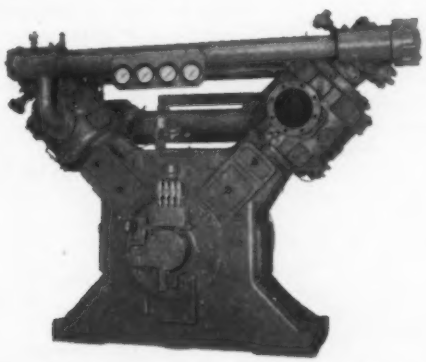

• 75 to 250 Horsepower
• For vacuum service and pressures to 5,000 pounds
• One to four stages of compression
• Built-in motor, coupled, and belt drive
• Simple, compact, widely adaptable, heavy-duty
• Built for "round-the-clock service"
with minimum of attendance
type Y
COMPRESSORS
Chicago Pneumatic
8 East 44th Street, New York 17, N. Y.



Butane **compressor, direct coupled to an explosion-proof motor, in a prominent refinery.**



Non-lubricated, **single-stage compressor driven by steam turbine through a reduction gear.**



Four-stage **high pressure unit available with flange-mounted,** belted, or coupled drive.

For more data on advertised products, use Readers' Service Cards, last page.

One of a series.

Some Things to Think About Steam Traps

...in order to get high operating efficiency and a minimum of maintenance

The gentleman who invented the wheel had a basic idea and so far no one has come up with anything better for the purpose.

If you'll pardon us for a little overemphasis on the significance of steam traps, we'd like to liken one of them to the wheel.

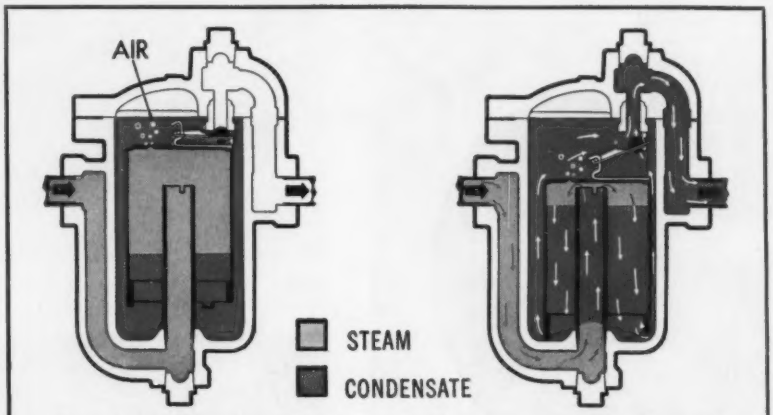
In 1911, when the first Armstrong inverted bucket steam trap model was announced to the world, or at least that part of the world that modest advertising and sales budgets would cover, it was not received with equal enthusiasm by all (especially old-style trap makers). But, like the wheel, it managed to find its way into general use. And, nothing better has ever turned up for the purpose of draining condensate. As a matter of fact, the Armstrong trap has been very widely copied. Today, there are more inverted bucket traps draining process equipment than any other kind. Of these, there are more Armstrongs.

If this sounds like the boasting of a proud parent, give consideration to some fundamental requirements not met by all traps:

1. ***A steam trap should not leak steam.*** Some traps do, you know, because of the nature of their operating principle. No steam ever gets to the Armstrong trap orifice. The valve is always water sealed.

2. ***A steam trap should vent "air" as fast as it accumulates***—otherwise temperatures are reduced and corrosion is a problem. The Armstrong trap handles air very nicely. The vent in the bucket permits air to accumulate in the top of the trap, from where it is discharged when the trap opens. For extreme conditions like draining paper machine dryers, some jacketed kettles and certain other units, the vent is sized larger for the job. And, for handling big volumes of air during warm-up, a bucket with an auxiliary thermic vent really speeds up heating.

3. ***A steam trap should discharge condensate at steam temperature*** if you want to get maximum efficiency from the unit drained. And most people certainly do. If you have to wait for the condensate to cool, it's almost impossible to maintain maximum temperatures and prevent air build-up. You guessed it—the Armstrong trap opens for water, without dependence on temperature.



Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

4. ***A steam trap should be suitable for any return system.*** The Armstrong trap works just the same whether discharging to atmosphere, back pressure or vacuum. It has been conclusively proved that flash steam resulting from use of a bucket trap does not cause a problem in vacuum return systems. The flash condenses rapidly. It's the leaky traps that cause the headaches.

5. ***A steam trap should not be a "prima donna".*** Some kinds of traps take an awful lot of care and coddling. The Armstrong trap is a rough and ready type with a hardened chrome steel constitution (valve and seat, to be exact). It cleans itself of ordinary dirt and scale without choking up. Its 18-8 stainless parts stave off rust and corrosion. It resists wire-drawing and wear remarkably well. In fact, it stays on the job longer with less attention than any trap ever produced. Unless you live in Siberia, you can probably find a user around the corner who will tell you so from experience.

6. ***A trap should not be an "orphan".*** With Armstrong traps you can *always* get prompt service and parts from nearby Factory Representatives and stocking distributors as well as from the factory.

7. ***A trap should have a guarantee.*** The Armstrong trap is unconditionally guaranteed to give you *complete satisfaction* (as to doing its job, that is). If it doesn't, you can get your money back.

If you'd like to buy some of these excellent steam traps, call your local Armstrong Representative or write **Armstrong Machine Works, 8527 Maple St., Three Rivers, Michigan.**

ASK FOR the 44-page Steam Trap Book, free on request without obligation.

ARMSTRONG STEAM TRAPS

For more data on advertised products, use Readers' Service Cards, last page.

BUTANE to BUTADIENE

in a single step

HOUDRY DEHYDROGENATION PROCESS

gives one-step process simplicity and flexibility in transforming . . .

BUTANE to BUTADIENE or BUTENES

BUTENES to BUTADIENE • ISOBUTANE to ISOBUTENE

Other light hydrocarbons to mono- and di-olefins

The Synthetic Rubber Industry is growing through expanded butadiene production made available by the Houdry Dehydrogenation Process. Houdry has designed and licensed over 50% of all new U.S. butadiene capacity built since 1946. In the past two years alone over 250,000 annual tons of Houdry butadiene capacity has been licensed. These units are either already in operation or nearing completion.

Over 12 years of commercial performance has firmly established a record of flexibility and economy worth investigating. Write for process literature and application assistance.

PROCESS-PROVED CATALYST

Houdry Chrome-alumina Dehydrogenation Catalyst is the result of fundamental and applied research combined with manufacturing experience. For single step olefin and di-olefin production from paraffins, Houdry Chrome-alumina is unequalled for long-term stability and selectivity.

HOUDRY

PROCESS CORPORATION

1528 Walnut Street, Philadelphia 2, Pa.

PIONEER IN CATALYTIC PROCESSES

For more data on advertised products, use Readers' Service Cards, last page.

How to get more storage space with BLAW-KNOX Electroforged® Steel Grating

You can get additional badly needed storage space easily and economically in your present building simply by installing platforms of Blaw-Knox Grating. It fits easily, neatly around pipes, beams and machinery without any alterations to your building.

Maintenance costs are slashed into the bargain. There's nothing to wear, nothing to patch. Blaw-Knox grating is self cleaning too. No sharp corners to clog up with dirt, and you'll find painting is easy since all surfaces are easily accessible.

You get maximum open area for plenty of light and ventilation. What's more, its rigid one-piece construction means maximum structural strength and load bearing capacity.

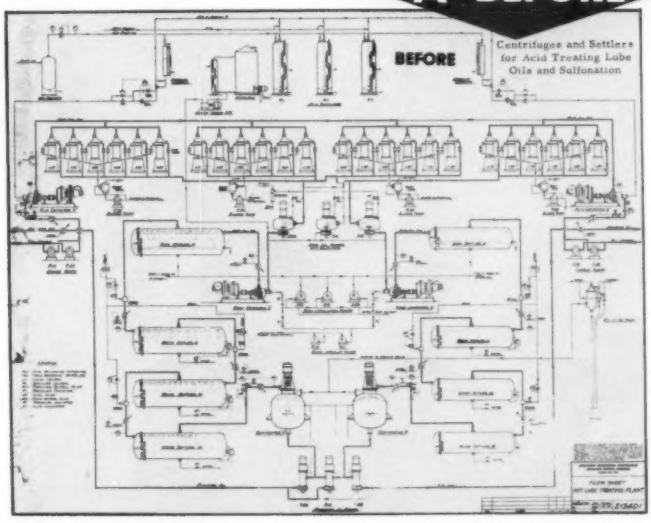
Blaw-Knox Electroforged Grating for walkways, stair treads and floors is fabricated to your specifications to meet your own operating requirements. Complete data on all types is contained in Bulletin 2527. Write for your copy today.

BLAW-KNOX

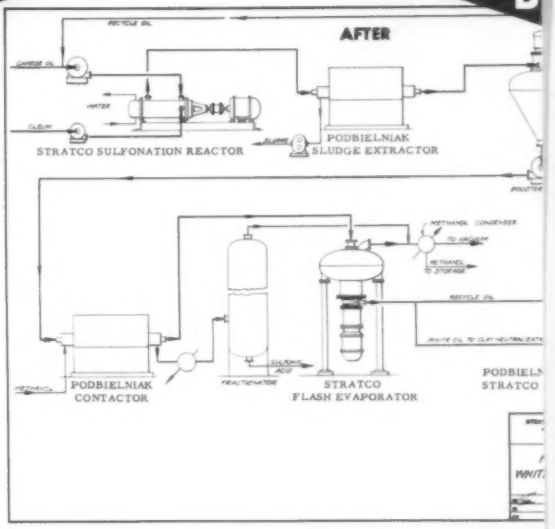
BLAW-KNOX COMPANY
Blaw-Knox Equipment Division
Dept. D, Pittsburgh 38, Pa.

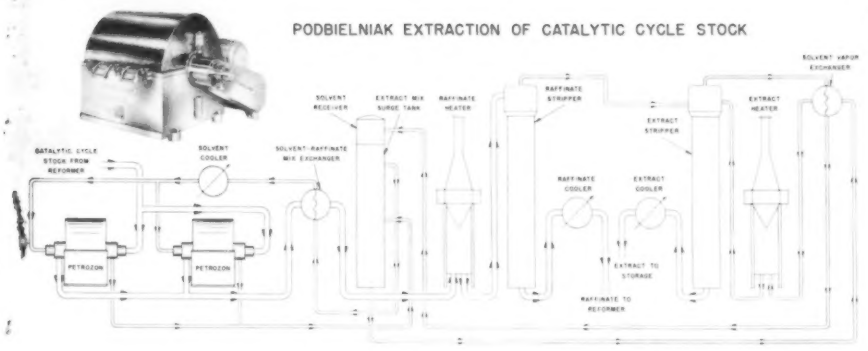
The *CHANGING SCENE* in modern plant processing flow

"A" BEFORE



"B





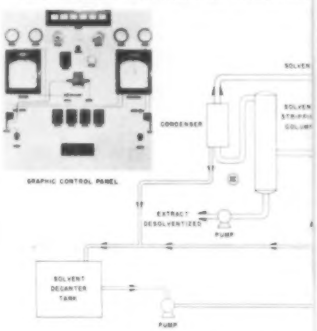
Advantages of Podbielniak Petrozon

1. Raffinate and extract streams centrifugally clarified—reducing load on strippers.
2. High capacity throughput with low holdup permits rapid attainment of equilibrium in one hour—special advantage to "blocked out" operations.
3. "Off Test" Material reduced to a minimum.
4. High pressure and temperature conditions with fully automatic operation.
5. Low capital investment and maintenance costs.

Advantages specific to catalytic stock and aromatic extractions

1. Process allows 50% increase of virgin catalytic cracker charge.
2. Coke-burning requirements reduced by 50%.
3. Production of Poly gasoline increase.
4. Octane level of total gasoline improved.
5. Low solvent inventory makes expensive selective solvent systems feasible.

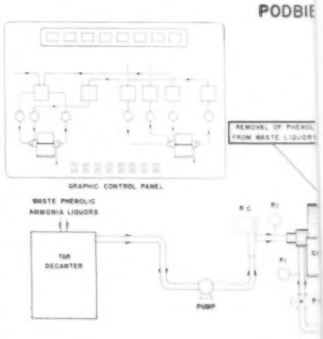
PODBIELNIAK CONTINUOUS COUNTER



Advantages of Podbielni with Solvent Rec

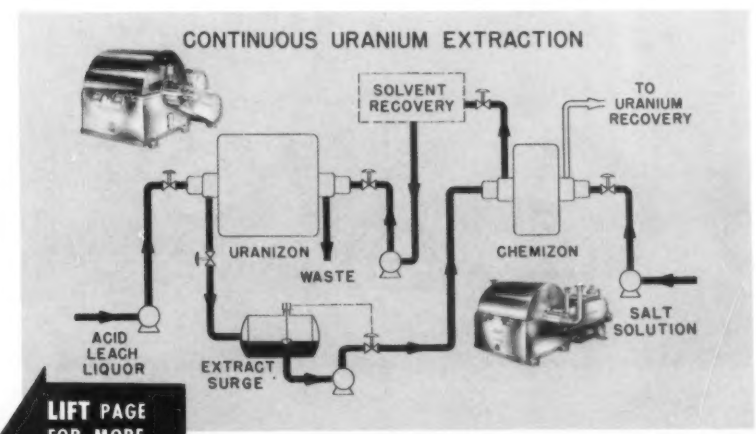
1. Solvent extraction plant in a packaged unit.
2. Adaptable to all liquid-liquid extraction systems.
3. Podbielniak Chemizon will separate systems with specific gravity differential as low as 0.015.
4. C
5. L
6. S

PODBIE



Advantage

1. Phenol concentration reduced to 5-10 P.P.M.
2. Excellent caustic economy.
3. Closed pr system.
4. Immediate generation vent inven

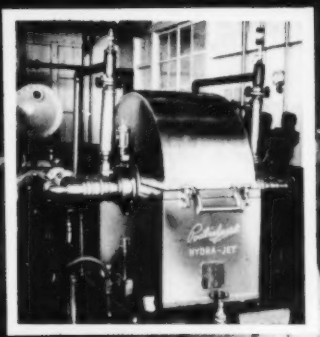


LIFT PAGE FOR MORE INFORMATION

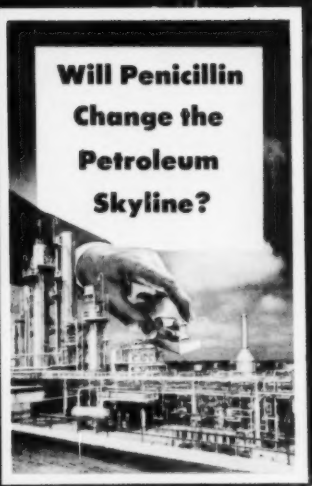
The *MASTER PUPPETEER* and the *AROUND THE WORLD!*

PODBIELNIAK CONTACTORS and SOLVENT EXTRACTORS are available in a variety of models designed for your specific process, ranging in capacity from a complete laboratory extraction plant of 500 cc per minute to intermediate and commercial size units up to 90,000 GALLONS PER HOUR.

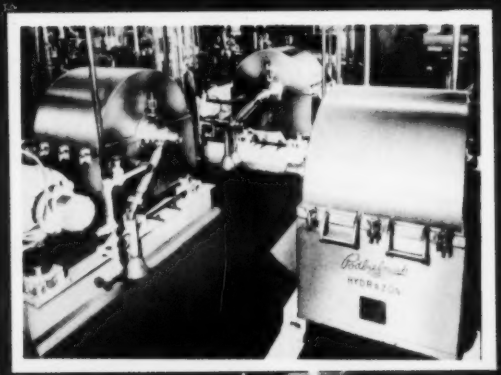
AQUAZONS
HYDRA-JETS

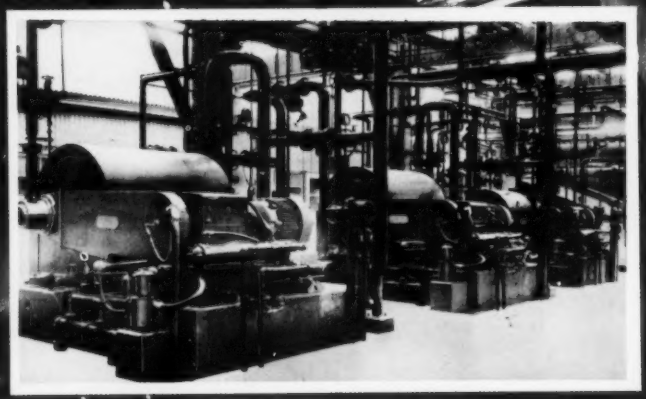


Will Penicillin Change the Petroleum Skyline?



PODBIELNIAK **HYDRAZONS** AND **DUOZONS** PROCESSING SOYBEAN OIL IN A VEGETABLE OIL REFINING PLANT

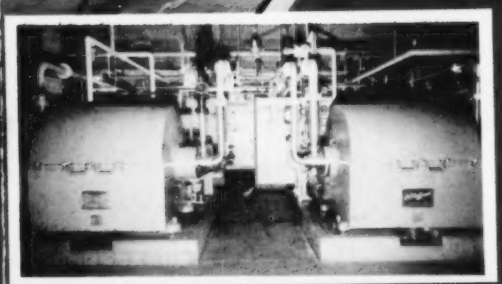




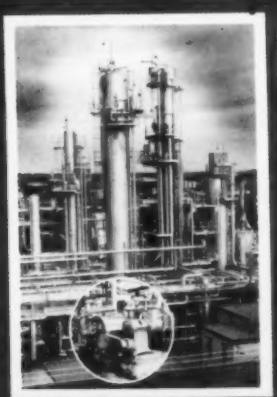
BATTERY OF PODBIELNIAK **PETROZONS** IN A MODERN PETROLEUM REFINERY

PODBIELNIAK **URANIZON** — EXPERIMENTAL WORK ON URANIUM REFINING

CHANGING SCENE

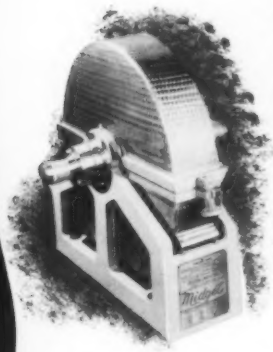


PODBIELNIAK **CHEMIZONS**
FOR REMOVING PHENOL FROM
COKE OVEN WASTE LIQUORS



PODBIELNIAK INSTALLATION IN
A PETROCHEMICAL PLANT

From eye-dropper capacity (200 cc/-min) to a Niagara Cascade—90,000 GPH



PODBIELNIAK **MIDGET** CONTACTOR (200 cc/min)

PROCESS INDUSTRIES USING PODBIELNIAK CONTACTORS AND SOLVENT EXTRACTORS

AQUAZONS
Crude Oil Desalting • Contaminated Oils
Insulating Oils • Lube Oil Purification

BIOZONS
Antibiotics • Biochemicals • Medicinals
Penicillin

CHEMIZONS
Beverages • Chemicals
Coal Tar Derivatives • Coke Oven Chemicals
Germicides and Insecticides • Petrochemicals
Plastics

DUOZONS
Animal Oils • Fish Oils
Vegetable Oil Degumming

HYDRA-JETS
Antibiotics • Chemicals • Hormones
Petrochemicals • Vegetable Oils

HYDRAZONS
Animal Oils • Fish Oils
Lacquers and Drying Oils
Resin Washing • Vegetable Oils

MINERALZONS
Rare Earth Refining

PETROZONS
Lube Oil Refining • Petrochemicals Extraction
Petroleum Refining

PHASEZONS
Phase Separation and Clarification in All Industries • Beverages
Pulp and Paper • Yeast Separation

SOAPRAZONS
Continuous Soap Processing
Synthetic Detergents

URANIZONS
Uranium Recovery

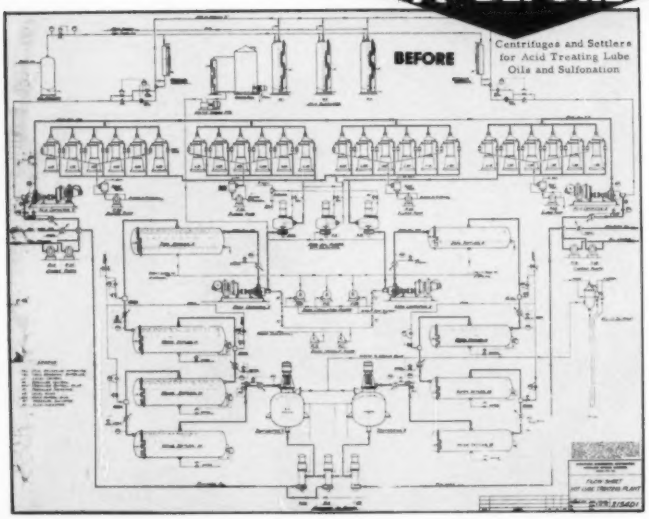
VEGEZONS
Animal Oils Refining • Fish Oils Refining
Vegetable Oils Refining

PODBIELNIAK, INC. 341 E. OHIO ST. • CHICAGO 11, ILL.

Write in for Engineering Questionnaire Brochure No. 10, and Technical Bulletin No. C-110.
No obligation for our investigation of your current operations.

The *CHANGING SCENE* in modern plant processing flowshe

"A" BEFORE



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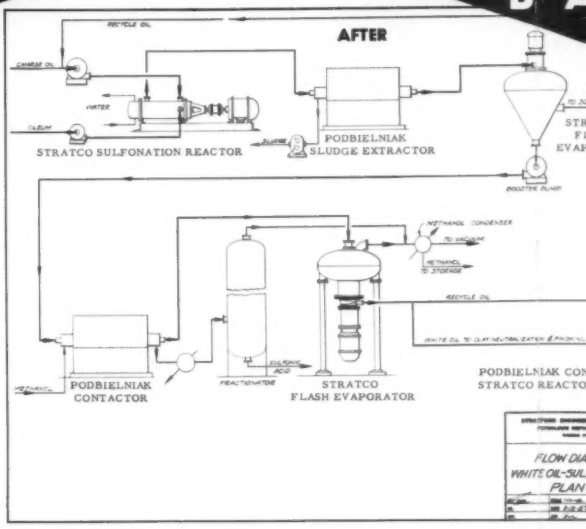

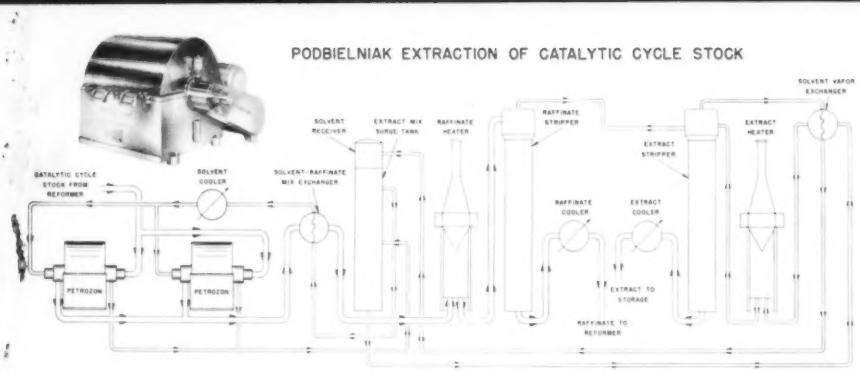

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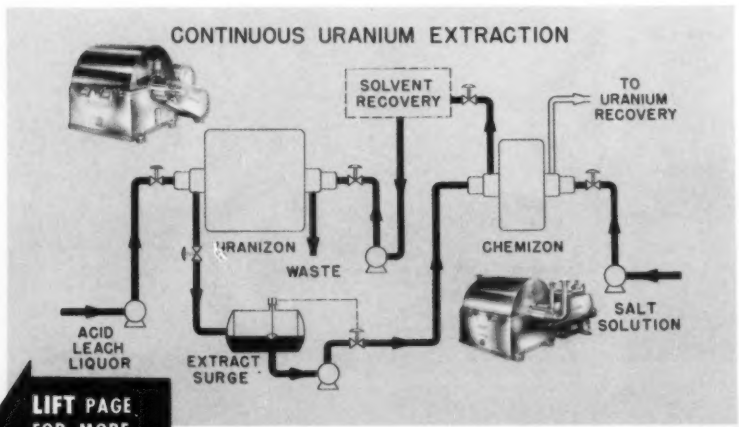

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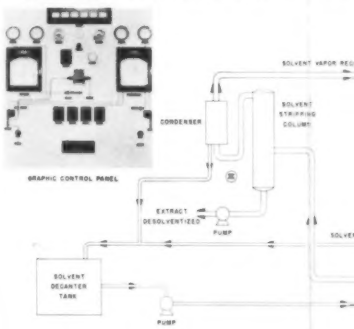
PODBIELNIAK CONTINUOUS COUNTERCURRE



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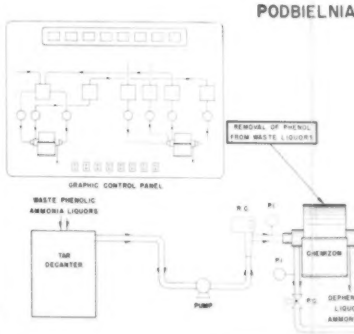
1. Solvent extraction plant in a packaged unit.
2. Adaptable to all liquid-liquid extraction systems.
3. Podbielniak Chemizon will separate systems with specific gravity differential as low as 0.015.
4. Comple tion for vent rec
5. Low cap operatin
6. Solvent low solv

PODBIELNIA



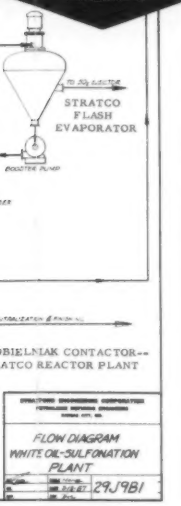
Advantages of

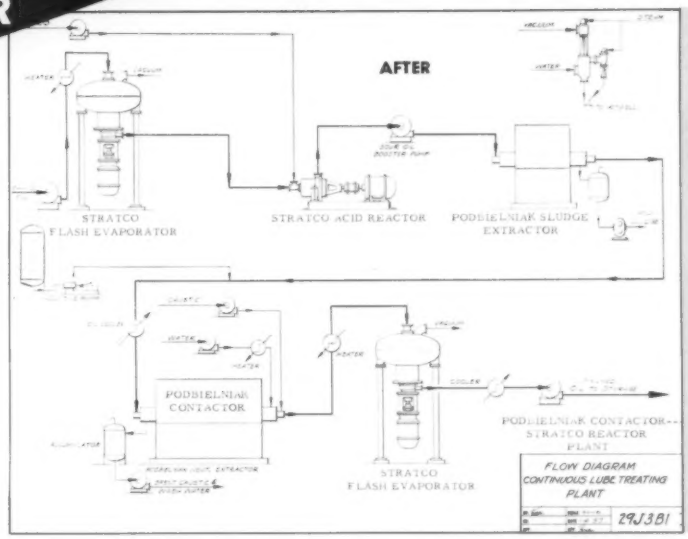
1. Phenol concentration reduced to 5-10 P.P.M.
2. Excellent caustic economy.
3. Closed pressur system.
4. Immediate solve generation keep vent inventory l

wsheets using PODBIELNIAK Contactors

TURN YOUR LOSSES INTO GOLD!!
MODERNIZE YOUR PLANT OPERATIONS!!
WRITE FOR QUESTIONNAIRE.

"B" AFTER





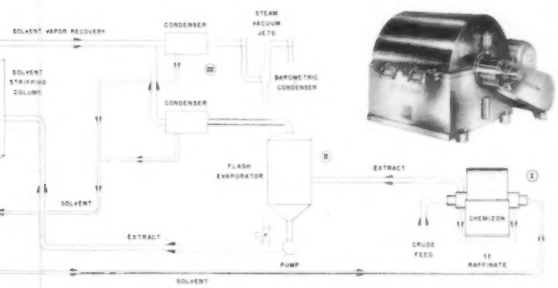
FLOWSHEET "A" illustrates the complicated assemblage of equipment BEFORE using PODBIELNIAK CONTACTORS.

It dramatically demonstrates the complexity of a *batch* process required in a lube treating plant with conventional-type centrifuges.

FLOWSHEET "B"
PODBIELNIAK CONTACTOR-STRATCO REACTOR PLANTS

The "changing scene" in plant processing using PODBIELNIAK CONTACTORS is well demonstrated in the three flow sheets shown at left on this page. TWENTY-FOUR centrifuges are replaced with FOUR desk-size PODBIELNIAK CONTACTORS.

NTERCURRENT SOLVENT EXTRACTION WITH SOLVENT RECOVERY



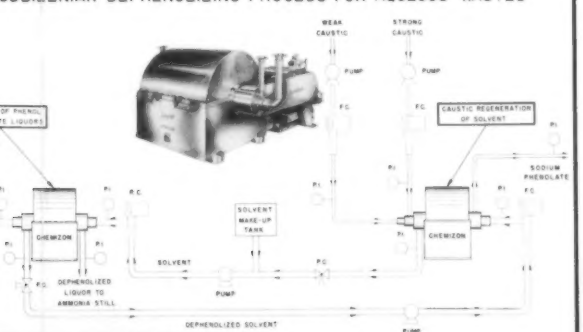
ielniak Chemizon Recovery

4. Complete automatic operation for extraction and solvent recovery.
5. Low capital investment and operating cost.
6. Solvent regeneration allows low solvent inventory.

LEGEND

I. Liquid-liquid countercurrent extraction and separation.
II. Flash evaporation of solvent.
III. Solvent stripping column.
IV. Solvent vapor recovery system.

ODBIELNIAK DEPHENOLIZING PROCESS FOR AQUEOUS WASTES



ntages of Podbielniak Chemizon

sed pressure tight em.
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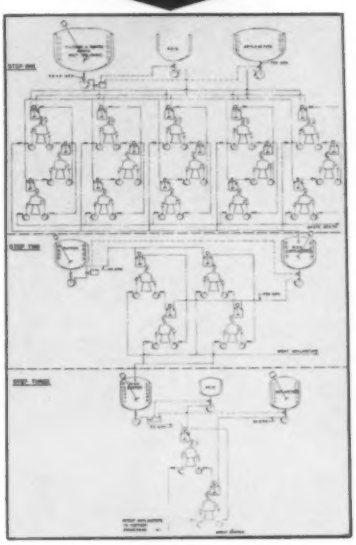
5. Exit streams centrifugally clarified.
6. Six extraction stages in one Chemizon.
7. Caustic treater regenerates solvent.
8. Flow rates of 1000 G.P.M. combined streams.

BEFORE



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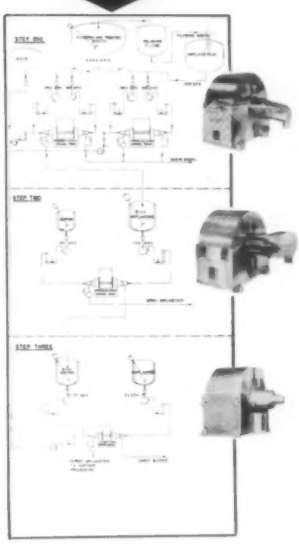

Economic Comparison of Podbielniak Centrifugal Solvent Extractors Vs. Mixer-Centrifuge Apparatus for Three-step Continuous Extraction of Penicillin

BEFORE

Process Flow Sheet

Complicated because of large number of separate units of equipment required to obtain equivalent of three-state extraction.

Refrigeration

Refrigeration of broth required in first step.

Cleaning

Necessary to disassemble centrifuges for cleaning requiring at least one hour per unit.

Maintenance

Large number of operating parts and complicated flow sheet requires constant attention of large maintenance force.

AFTER

Process Flow Sheet

Simplified since more than 5 stages of extraction available in a single, compact unit requiring only one set of pumps instead of three.

Refrigeration

Refrigeration of broth in first step not required.

Cleaning

Extractors cleaned in 10-15 minutes *without disassembly by simple flushing operation.*

Maintenance

Extractors "down time" for maintenance is less than 0.02% of "operating time."

PODBIELNIAK, INC.
341 EAST OHIO ST. • CHICAGO 11, ILL.

sheets using PODBIELNIAK Contactors

TURN YOUR LOSSES INTO GOLD!!
MODERNIZE YOUR PLANT OPERATIONS!!
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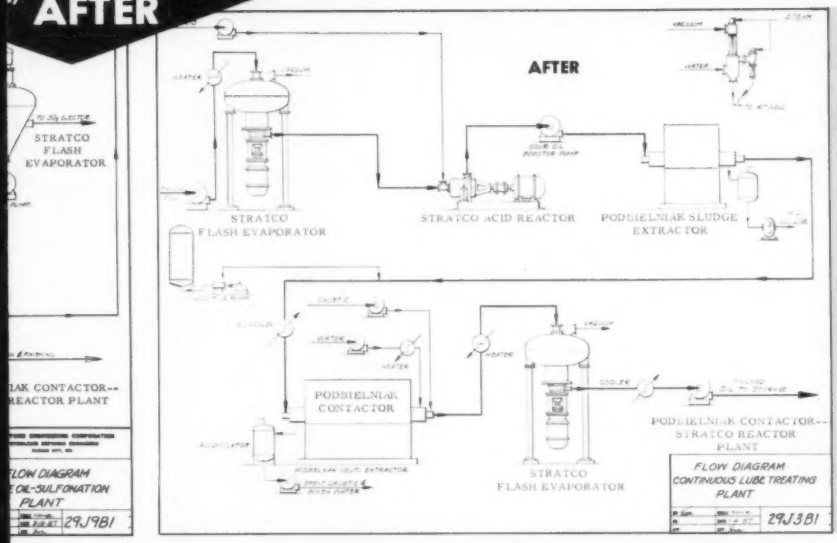

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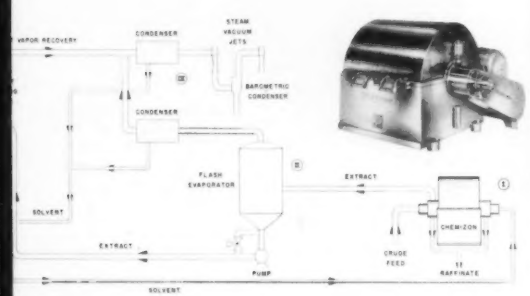

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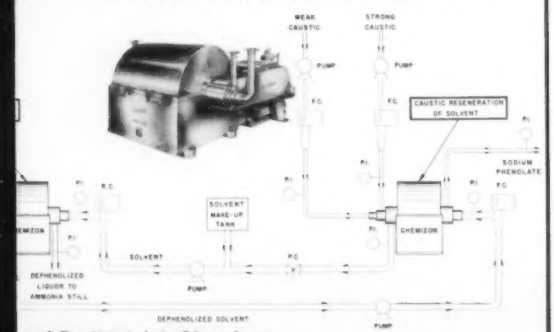

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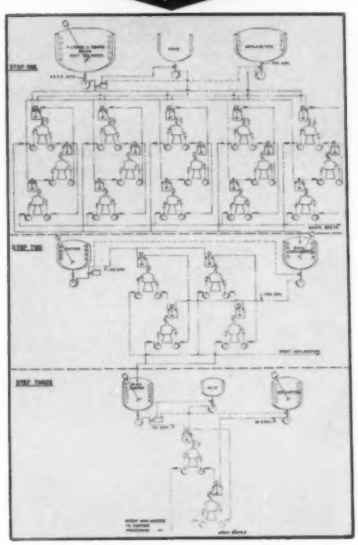

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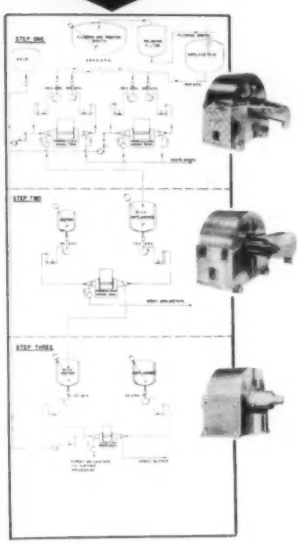

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PODBIELNIAK, INC.
341 EAST OHIO ST. • CHICAGO 11, ILL.

Send for this new folder

Learn the facts about money-saving, custom-engineered SOLA-FLEX® expansion joints

FORTY OF AMERICA'S fifty largest businesses are users of Sola-Flex expansion joints. They know that Sola-Flex joints are custom-engineered to meet every piping need, no matter how tough the temperature or pressure demands. And Sola-Flex joints are economical, too—in initial cost and long life.

They are made from a variety of stainless and high alloys, from ½ inch to 35 feet in diameter. They handle pressures up to 3500 psi for special applications. And they are being built for service from −320F to 1200F.

It will pay you to learn more about Solar's complete line of industrial bellows and expansion joints. Send for this new folder today. Write to Department D-101, Solar Aircraft Company, San Diego 12, California. *Designers, developers and manufacturers of gas turbines, expansion joints and aircraft engine, airframe and missile components.*

SOLAR AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

FOR NEW SOLA-FLEX FOLDER MAIL TO:
Dept. D-101, Solar Aircraft Company, San Diego 12, California

NAME_____

TITLE_____

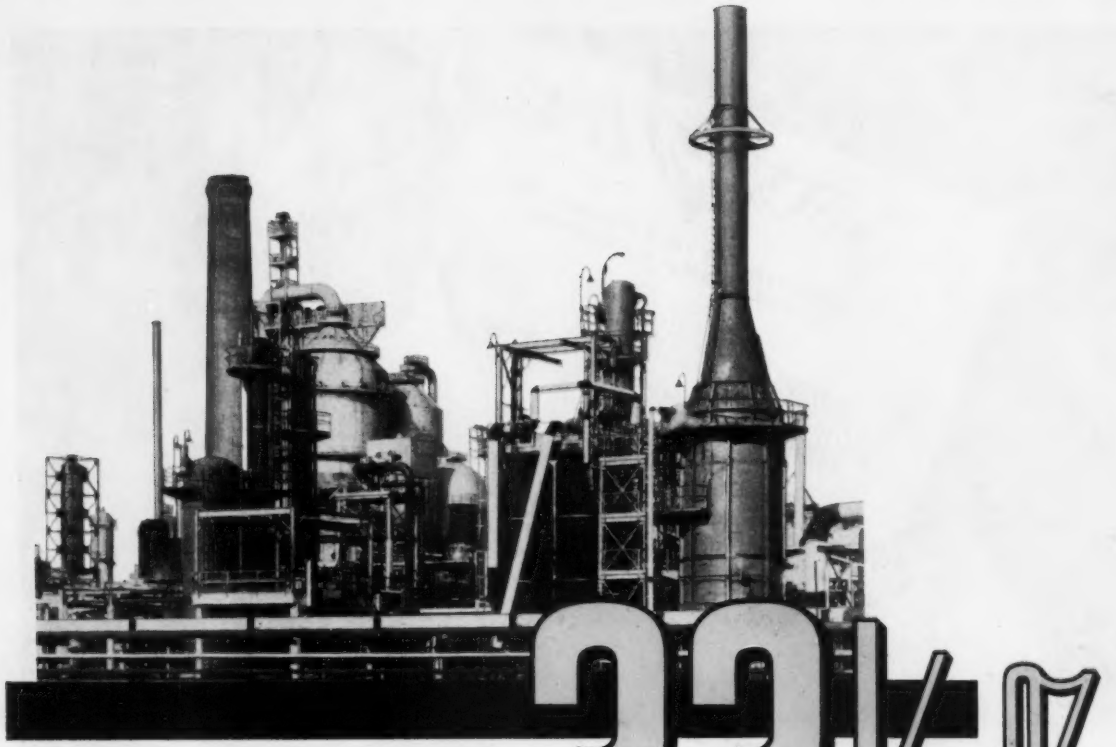
COMPANY_____

ADDRESS_____

CITY_____

ENGINEERS WANTED. *Unlimited opportunities, challenging projects, good living with Solar! Send for new brochure.*

For more data on advertised products, use Readers' Service Cards, last page.



OVER 33⅓%

UNDISPUTED LEADERSHIP IN DESULFURIZING OF PETROLEUM—

Contracts for design and construction of over 33⅓ % of the nation's total catalytic petroleum desulfurizing capacity have been awarded to Parsons.

Two plants, now under construction, are the largest in the world. They are a 40,000 B/D naphtha desulfurizer and a 50,000 B/D gas-oil desulfurizer.

This is only part of the background that has established Parsons' reputation in design and construction of hydrogen treating facilities.

PARSONS

means leadership

THE RALPH M. PARSONS COMPANY

NEW YORK
PASADENA
WASHINGTON

ANKARA
BAGHDAD
BEIRUT
JEDDAH
KARACHI
MADRID
NEW DELHI
PARIS
TORONTO

ENGINEERS • CONSTRUCTORS
LOS ANGELES

Today at Westinghouse— men like these are engineering new dependability for process automation

Developments in motor design and insulation . . . static control systems and power rectifiers show how Westinghouse engineering and research provide new dependability for confident expansion of automatic operation. Engineering is constantly probing, exploring and identifying the practical. Thus improving present products with better protection and longer life. You profit from minimum process interruption, reduced maintenance costs and new opportunity to expand safely.

Motor problems in chemical and petroleum processing dictated the design and improved materials for the Life-Line® "A" totally enclosed motor. Since insulation is a major factor determining process motor life, Westinghouse introduced Bondite* stator insulation. Bondite is a silicone-reinforced thermosetting varnish that has outstanding resistance to *both* corrosive liquids and vapors. Some stator insulations can be dipped into water with no adverse effect, but have low resistance to vapor. Bondite seals out both, whether water, oil or chemical.

In addition, Westinghouse Bondar* conductor insulation has a life expectancy of more than three times that of conventional conductor insulations. It improves resistance to heat, provides greater dielectric strength and greater resistance to moisture, oils, dust and dirt.

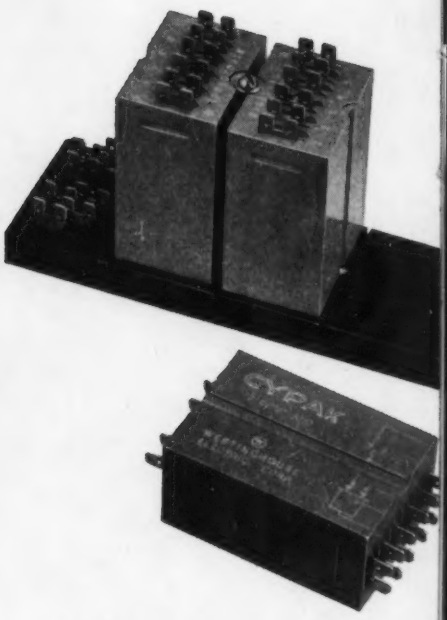
(*Continued on next page*)

MP-3053-1

*Trade-Mark

YOU CAN BE SURE...IF IT'S Westinghouse

Here's proof of new dependability to advance automation



Cypak static control and power bus

Cypak outlasts conventional control 15 times. Cypak* is the first static industrial control system with no moving parts to wear, corrode or jam. It is a revolutionary means of providing automatic electrical control for processing operations and coordinated materials handling. The Cypak memory operation is also designed for complete plant alarm systems.

Westinghouse Silicon Rectifiers are static devices which have been developed for use in the 300-volt class and below. Air-cooled Silicon Rectifier assemblies withstand extremely high temperatures and have an efficiency equal to or better than other conversion equipment.

Thermalastic, the insulation with a memory, remembers to expand and contract with the coil. This prevents tape separation, the major cause of insulation failure. Thermalastic® Insulation ignores water, chemicals, dirt and other contaminants. Over 40-million hp are protected by Thermalastic Insulation throughout industry today.

Large motor drive demonstrates 30% better protection.

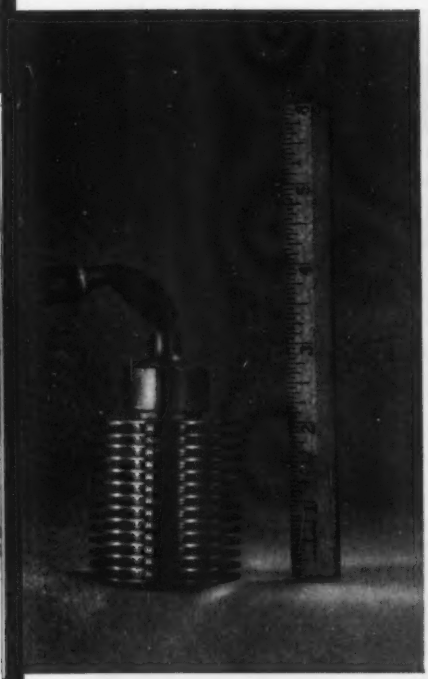
Thermalastic-insulated coils have proved a dielectric strength 30% higher than conventional types. In the picture at the right, water is sprayed into the air inlet opening while this 600-hp, 4160-volt squirrel-cage motor is running at normal speed. Immediately following the spraying, the coils successfully withstood three times the normal line-to-ground voltage.

Ten years ago, this picture could not have been taken. Thermalastic Insulation is the result of nine years' research and engineering and several million dollars' investment by Westinghouse.

Investigate all the many Westinghouse developments for drive dependability by calling your local Westinghouse salesman; or write, Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania. MP-3053-2

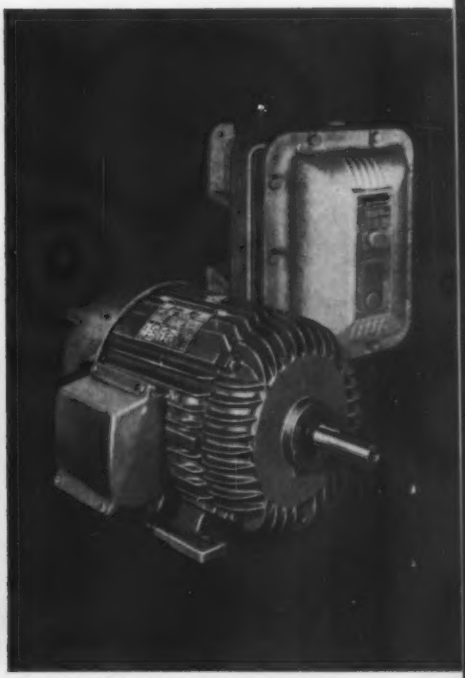
*Trade-Mark

YOU CAN BE SURE...IF IT'S Westinghouse



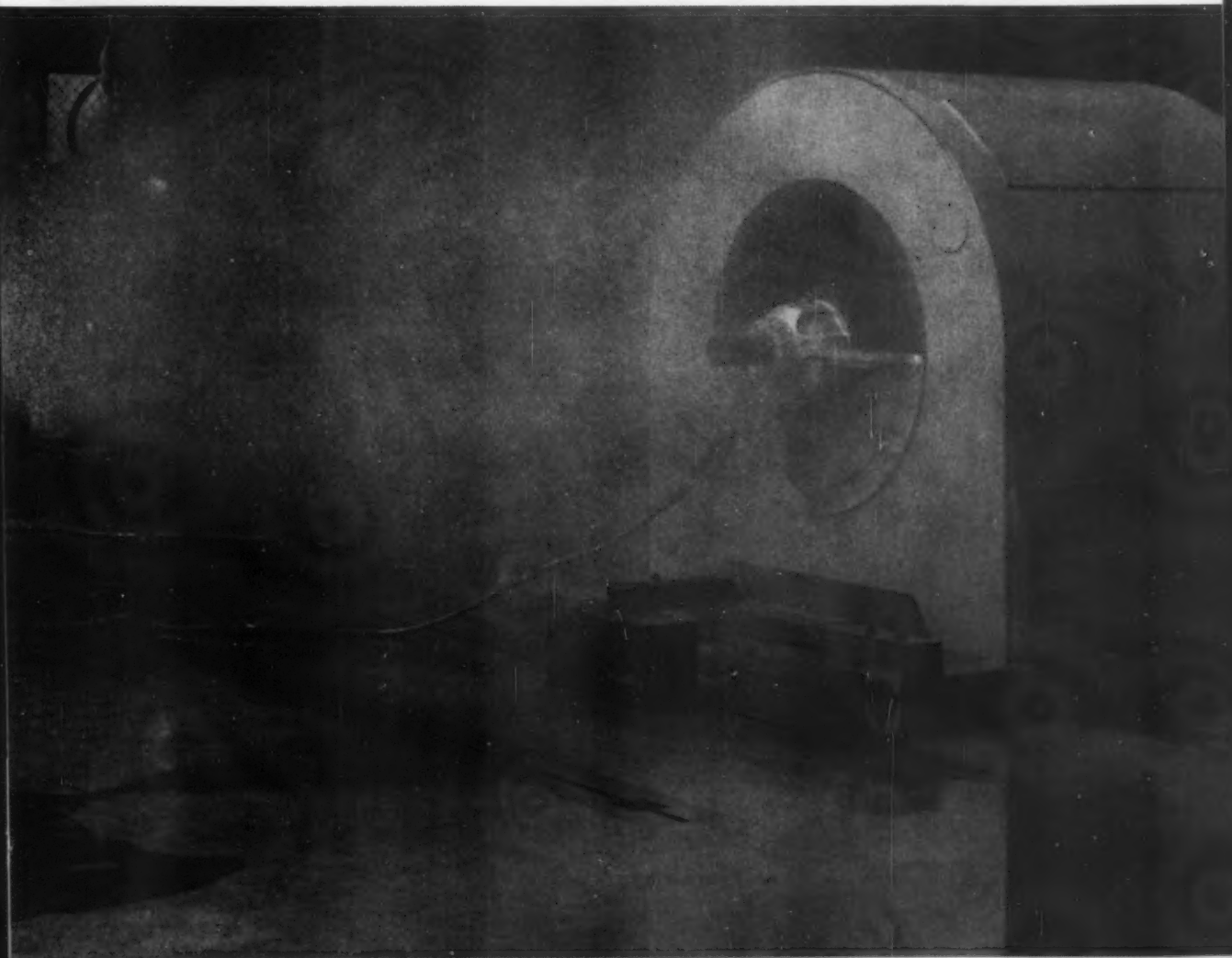
Westinghouse Silicon Rectifier

Applying Thermalastic Insulation



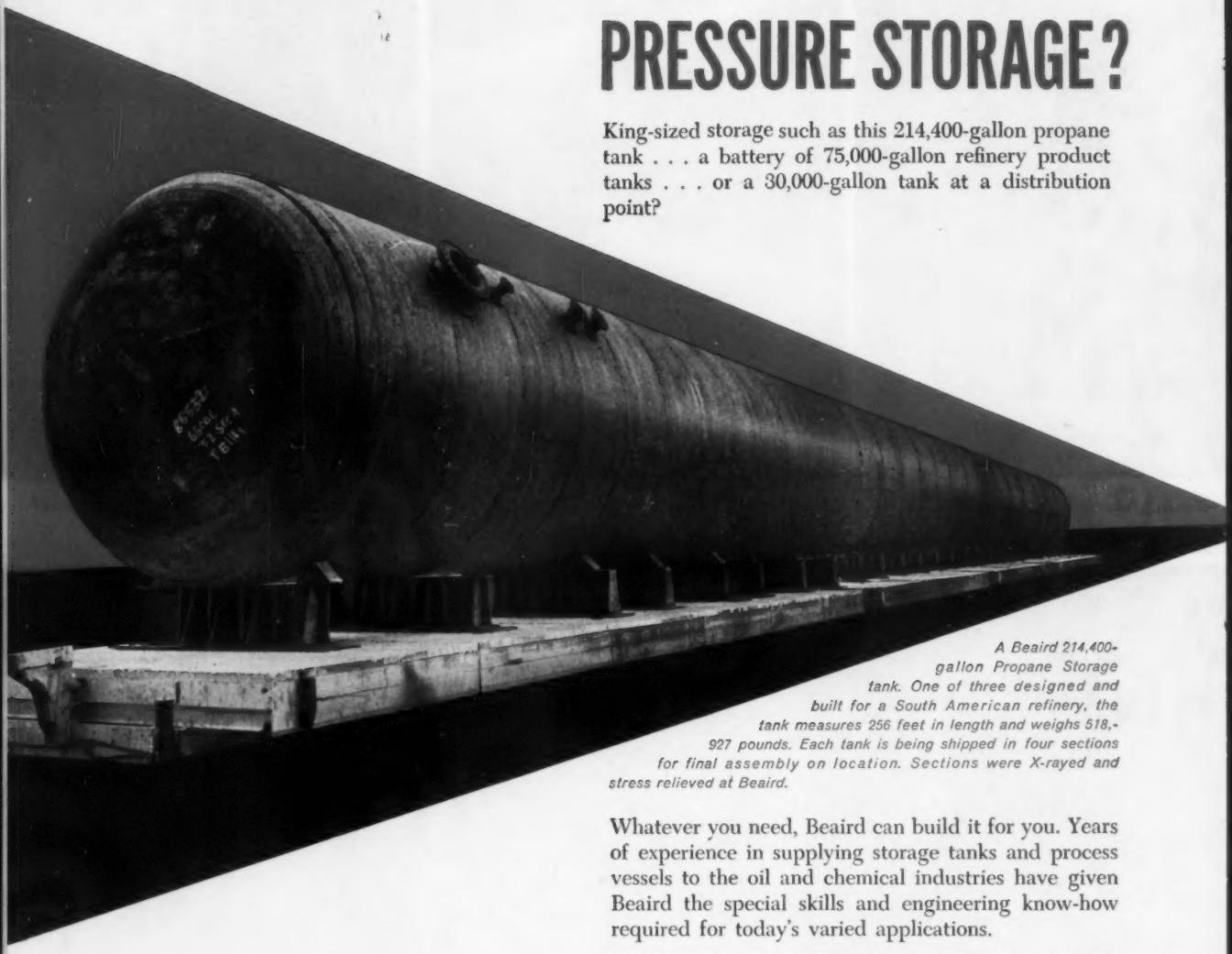
Life-Line "A" Motor and explosion-proof Life-Line Starter

MP-3053-3



What do YOU need in PRESSURE STORAGE?

King-sized storage such as this 214,400-gallon propane tank . . . a battery of 75,000-gallon refinery product tanks . . . or a 30,000-gallon tank at a distribution point?



A Beaird 214,400-gallon Propane Storage tank. One of three designed and built for a South American refinery, the tank measures 256 feet in length and weighs 518,927 pounds. Each tank is being shipped in four sections for final assembly on location. Sections were X-rayed and stress relieved at Beaird.

Whatever you need, Beaird can build it for you. Years of experience in supplying storage tanks and process vessels to the oil and chemical industries have given Beaird the special skills and engineering know-how required for today's varied applications.

You benefit as well from Beaird's Quality Control. Modern X-ray equipment, hydrostatic testing, stress relieving facilities, full-time insurance inspectors and strict adherence to fabricating code procedures all play important roles in building Beaird pressure storage.

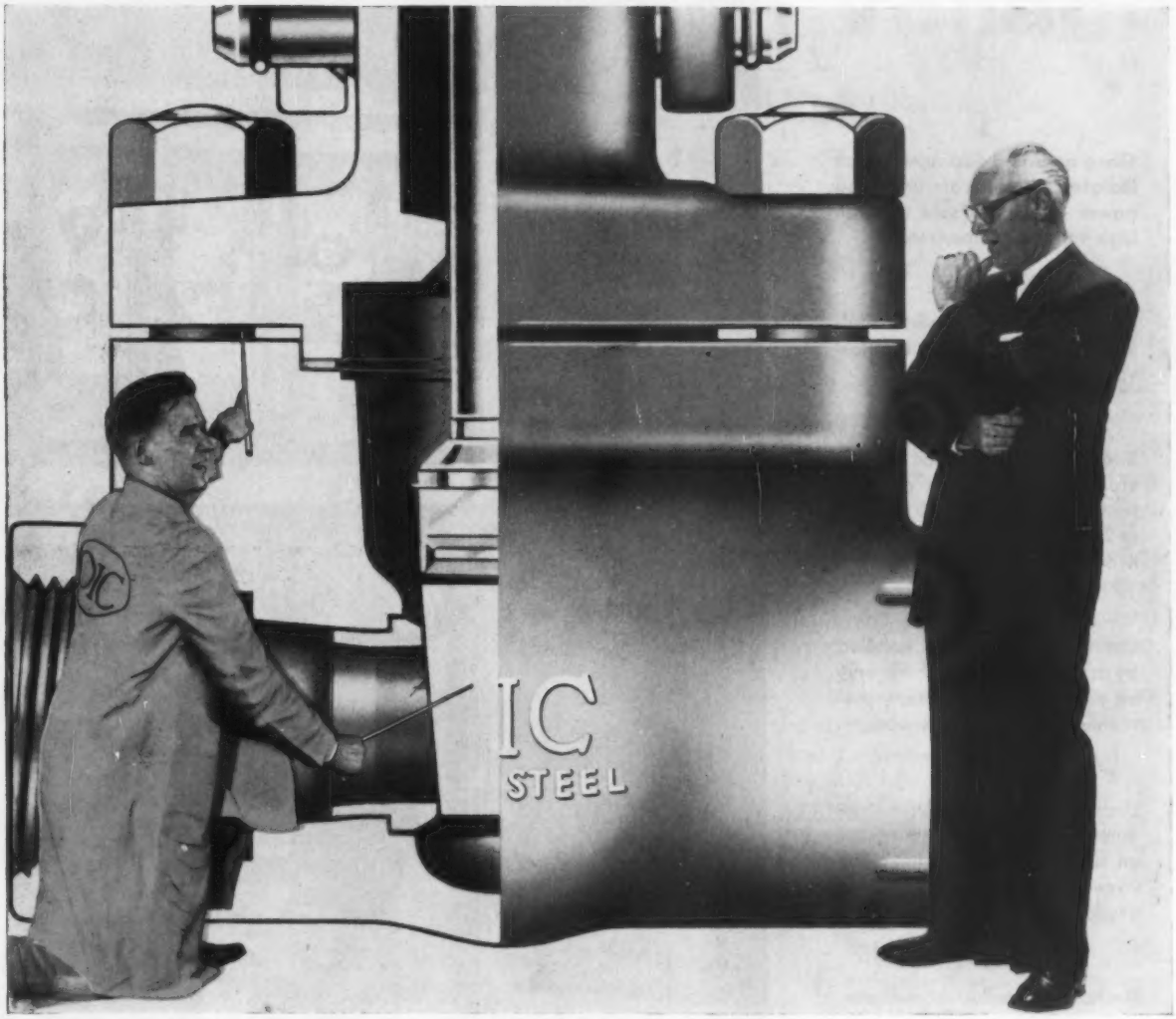
When your next project is in the idea stage, call in a Beaird sales engineer. His specialized knowledge can help you obtain maximum storage at lowest possible cost.

Over 200,000,000 Gallons Experience

BEAIRD
another AMF product
PRESSURE STORAGE VESSELS

THE J. B. BEAIRD COMPANY, INC.
A Subsidiary of American Machine & Foundry
Shreveport, La. • Stockton, Calif. • Clinton, Iowa

...and you can see here....and here, sir, how we've killed maintenance problems on our new forged steel lines.



We stop galling and erosion by giving you 13% chrome stainless steel trim with wedges *duracased* to a rugged *1000 Brinell hardness.*

The square and *bolted* body-bonnet joint makes it easy to service the valve quicker. And it's a tighter joint, made doubly leakproof by recessing the soft iron gasket into the body. The gasket can't blow!

And you get the fastest joint make-up you've ever seen. Look at those pipe ends. See the extra wrench-gripping area and lugs. See how body-bonnet flanges are out of the wrench's way. No time lost here!

These new 600-lb. OIC forged steel valves are available with either *high-flow* ports (1300 line), or *standard-flow* ports (1100 line). Call your OIC Distributor, or write for specification literature.

The Ohio Injector Company • Wadsworth, Ohio

OIC VALVES | BRONZE, IRON, FORGED AND CAST STEEL, LUBRICATED PLUG VALVES

For more data on advertised products, use Readers' Service Cards, last page.

Allis-Chalmers announces... **Newly**

1

Gang-operated disconnect switch isolates starter from incoming power — assures safe entry of high voltage compartments.

2

Steel cubicle is compartmentalized — separates high and low voltage equipment.

3

Short-circuit protection is provided by fast-acting current-limiting fuses, rated 150,000 kva at 2300 volts and 250,000 kva at 4160 or 4600 volts.

4

Overload protection is handled by accurate relays which trip only on excessive motor current, preventing needless motor stoppages.

5

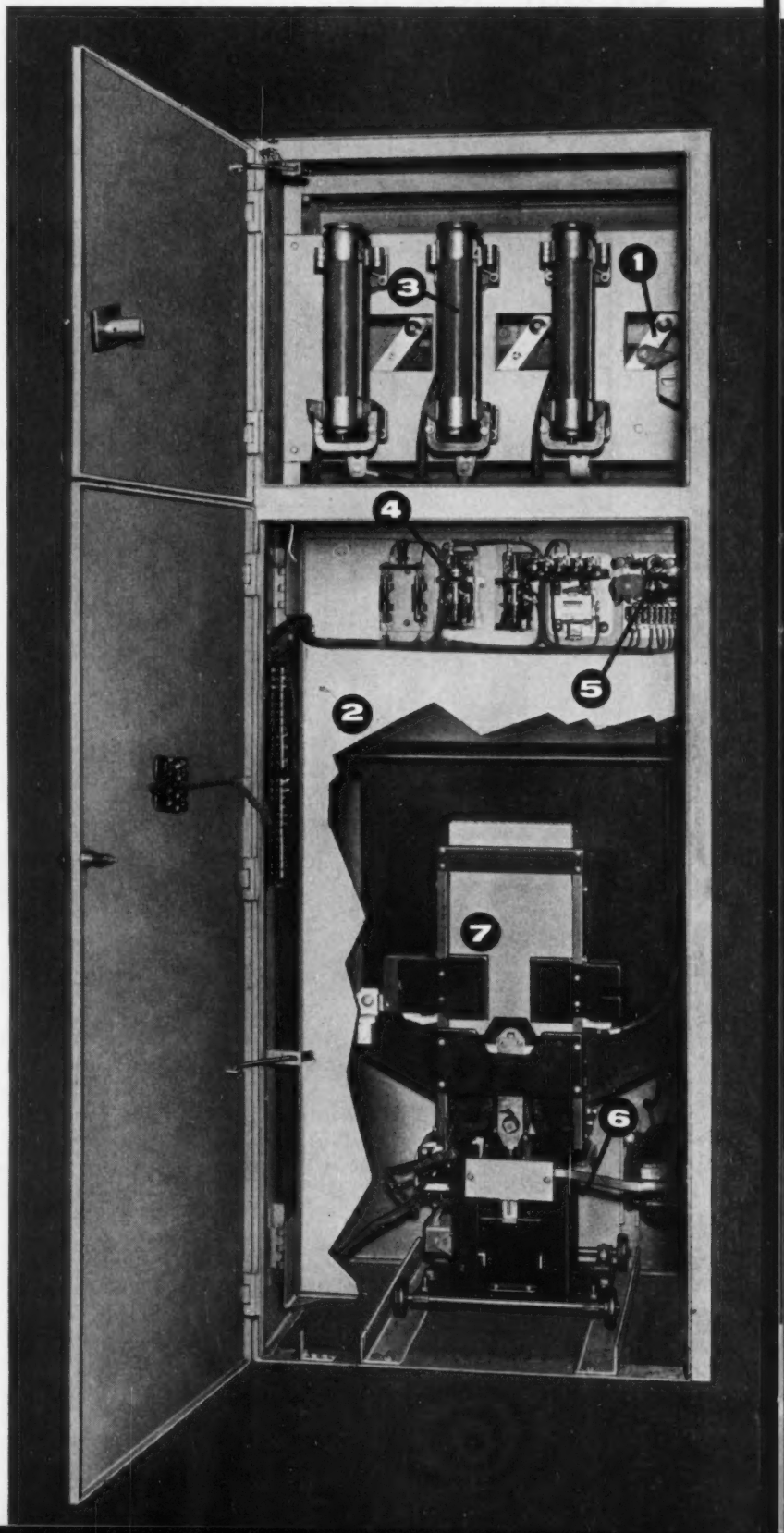
Undervoltage protection instantaneously opens line contactor on loss of voltage. Time-delay undervoltage protection also available.

6

Mechanical interlock coordinates contactor, disconnect switch, upper door and inner control barrier for maximum safety.

7

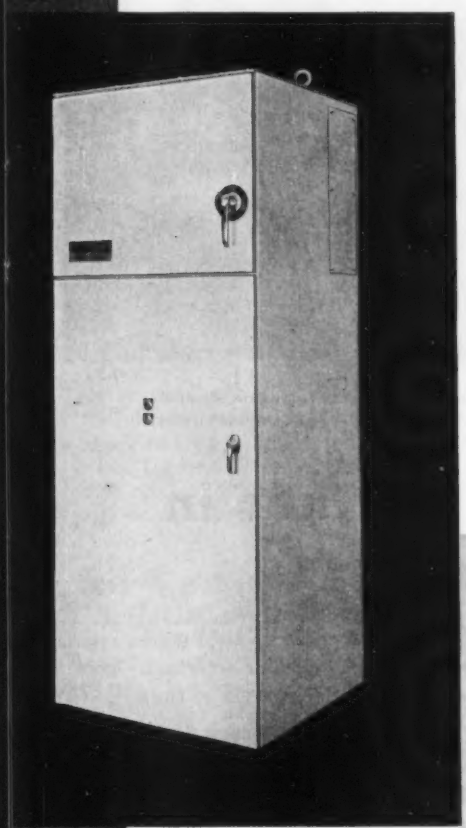
Roll-out contactor makes maintenance easy—even in narrowest aisle space. (Routine inspection and maintenance can be done with contactor in place.)



Designed

Type H High Voltage Motor Control

Combines front access with space economy...



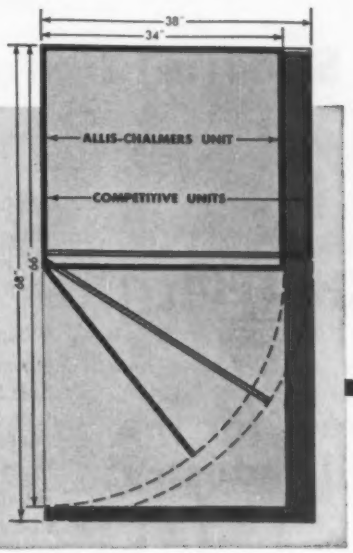
In addition, you get maximum protection for personnel and machines, thoroughly tested components, and ample panel space for modifications. It's all built into the *smaller cabinet* of a newly designed line of Type H high voltage starters from Allis-Chalmers.

Here is control that couples compactness with roominess (for ease of maintenance) . . . here is a starter that joins test-proven performance with versatility (for addition of meters and relays) — AND the line meets every 2300 to 5000-volt motor need.

For more information on this engineering advance, contact your A-C representative or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS UNIT requires 2.3 sq ft less floor space than any competitive unit. Put 10 A-C units in the same area needed for 9 cabinets of other manufacture.

Indicates 2.3-sq-ft saving in floor space



ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5517

Sheffield products go to sea . . . in the oil industry's offshore treasure hunt. Sheffield supplies many kinds of steel used in building the sea-going drilling platforms — man made "islands" that operate as far as 50 miles at sea.

Sheffield Steel Products Partner in Oil Industry Progress

SHEFFIELD
ARMCO

Steel for the Oil Industry

Wherever oil flows, steel goes. Steel is the master metal in field machinery and drilling rigs. In refinery equipment and pipeline arteries. In tanks and tankers. Can you imagine the fantastic progress of the oil industry without steel?

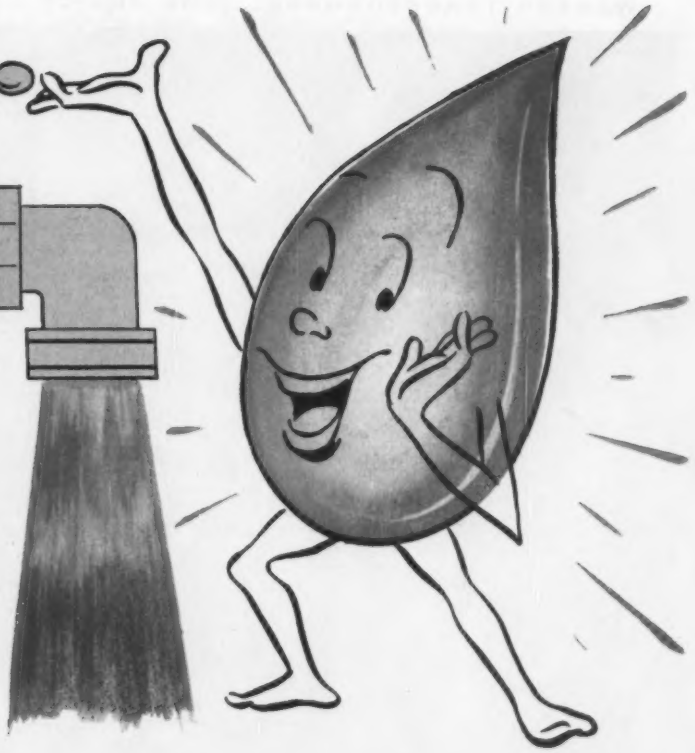
When you buy gasoline or oil (or any other petroleum product), chances are Sheffield steel played a part in getting it to you. For Sheffield is a major supplier of steel used by the oil industry.

Sheffield's three steel making mills are strategically located in the heart of the oil country. They make a widely diversified line of semi-finished and finished steel products for manufacturers and suppliers to the petroleum industry. Some of these Sheffield steel products: alloy and carbon steel billets, beams, plates and rods. Tankheads and hot-rolled merchant shapes. Bolts, skelp, wire products in big variety.

SHEFFIELD DIVISION ARMCO STEEL CORPORATION SHEFFIELD PLANTS: HOUSTON • KANSAS CITY • TULSA

For more data on advertised products, use Readers' Service Cards, last page.

ALLIS-CHALMERS
Water Conditioning



Announcing New Industrial Zeolite Water Softener

Basic standard water softener designs easily adapted to meet individual plant requirements.

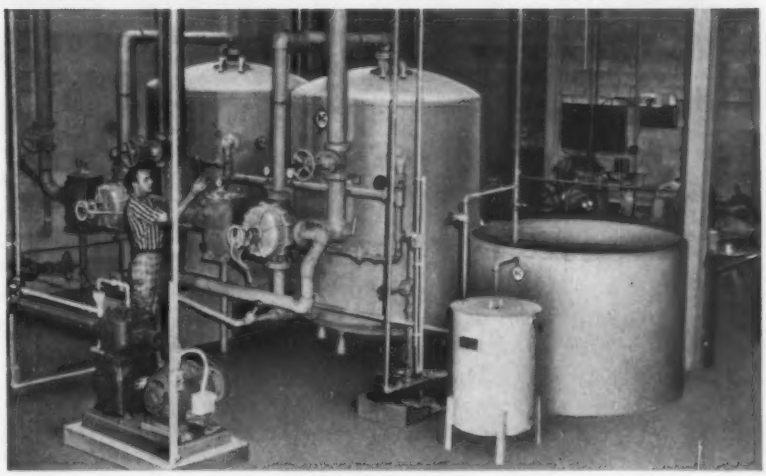
Here's a well-engineered, well-built answer to a wide range of water conditioning problems. It's designed to eliminate costly maintenance due to scaling of pipes and heat exchange tubes; to produce chemically suitable water for drying, paper making, textiles; and to provide water for food processing and many special industrial applications.

Easy Operation

The unit is basically simple. It is engineered to operate with little or no maintenance between regenerating cycles. Regeneration is an easy procedure. Automatic controls are also available to further simplify the operation if desired.

Standard Basic Design

Allis-Chalmers engineers started with a basic standard design developed from years of research and experience.



Allis-Chalmers sodium zeolite water softener installed in Ohio dye plant.

From this, a water softener is engineered to meet your individual plant requirements. Such factors as size of softener tank, size of salt and brine tank can be varied to meet your conditions.

Get Details

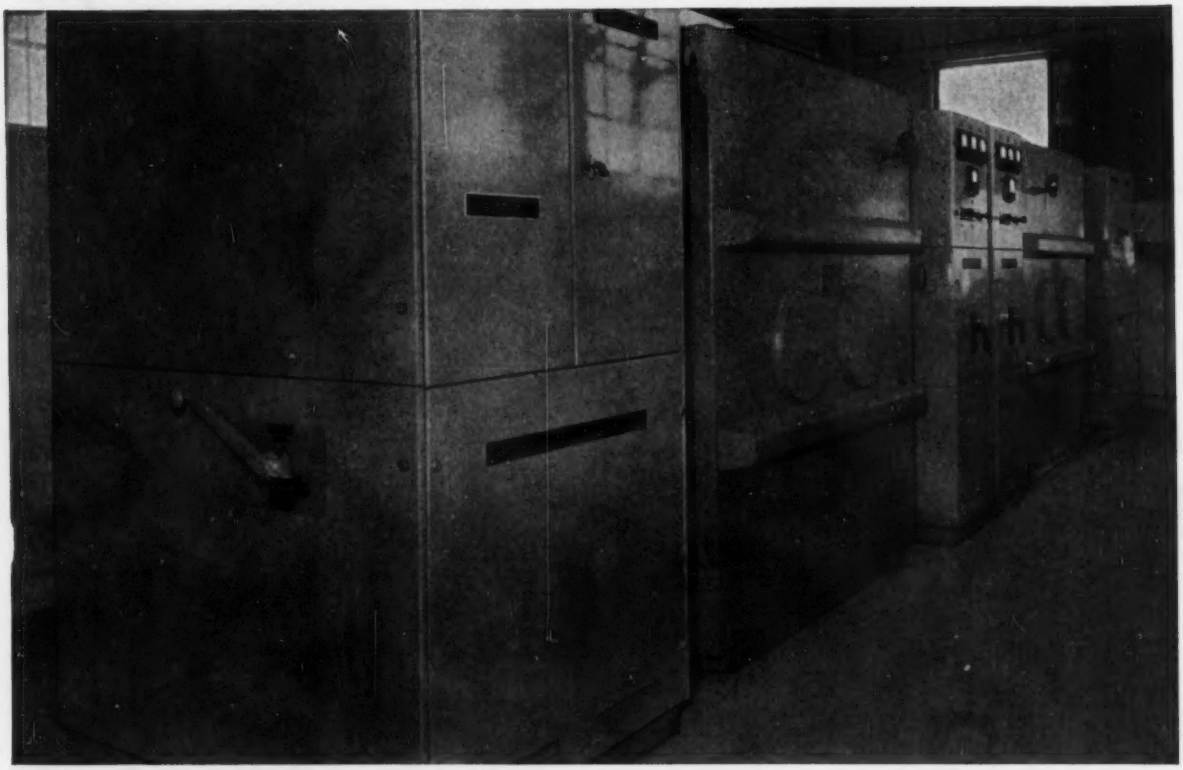
For complete details about Allis-Chalmers industrial type zeolite water softeners, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS A-C ALLIS-CHALMERS

A-5552

For more data on advertised products, use Readers' Service Cards, last page.

WAGNER TRANSFORMERS . . . THE CHOICE OF LEADERS IN INDUSTRY



Wagner Sealed Dry-Type Transformers can serve under the most adverse conditions

Impervious to DUST, LINT, HUMIDITY, HIGH AMBIENT TEMPERATURES, FLOODING—no need for vaults or barriers

Here's a unit substation transformer that you can safely install in any load center—any place—no matter how tough the operating condition.

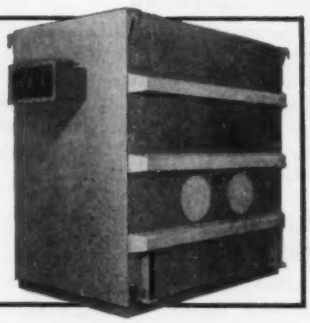
Wagner Sealed Dry-Type Transformers are hermetically sealed in a welded steel case to provide positive protection from contamination, fire and explosion hazards.

Class H insulation is used throughout the transformer. Core and coils are impregnated with silicone varnish and are sealed in the case which contains inert-dry-nitrogen under pressure to prolong insulation life. Maintenance is reduced to periodic checking of bushings case and gas pressure.

Available in ratings from 300 to 2000 kva, 5 or 15 KV high voltage, 480 volts low voltage. For complete information on these sealed dry-type transformers, write for Bulletin TU-214 or call the Wagner branch office near you.

PREDESIGNED
to save you money

Wagner Nitrogen-Filled Dry-Type Transformers save you individual job engineering time and cost. That's because they are PRE-DESIGNED in standard ratings coordinated with the specifications of unit substation switchgear builders. These standard designs assure quicker delivery of the correct transformer for your load center installation.



Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

T37-11

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation
6458 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

For the petroleum industry...

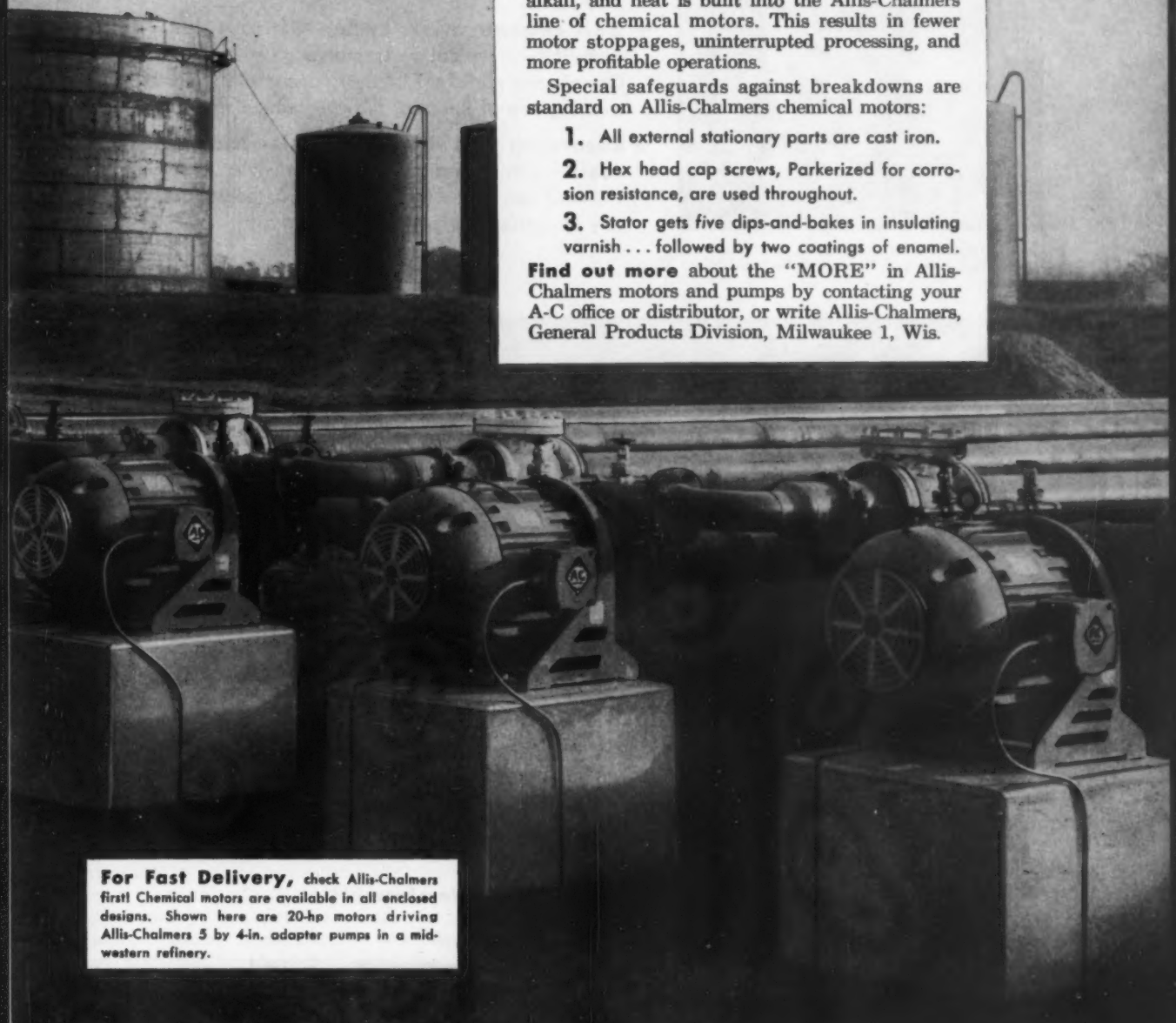
There's MORE continuous processing with Allis-Chalmers chemical MOTORS and PUMPS

Maximum protection against moisture, acid, alkali, and heat is built into the Allis-Chalmers line of chemical motors. This results in fewer motor stoppages, uninterrupted processing, and more profitable operations.

Special safeguards against breakdowns are standard on Allis-Chalmers chemical motors:

1. All external stationary parts are cast iron.
2. Hex head cap screws, Parkerized for corrosion resistance, are used throughout.
3. Stator gets five dips-and-bakes in insulating varnish . . . followed by two coatings of enamel.

Find out more about the "MORE" in Allis-Chalmers motors and pumps by contacting your A-C office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

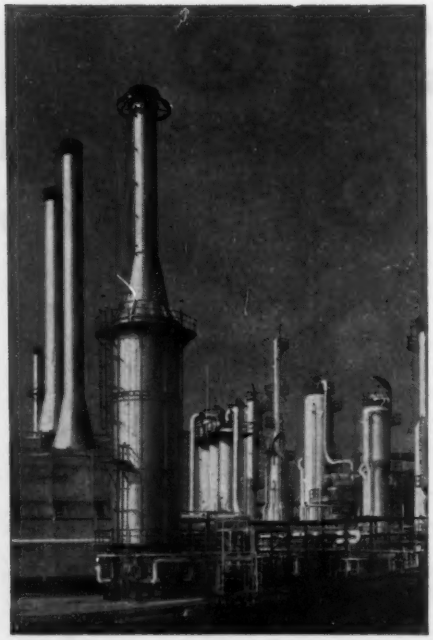


For Fast Delivery, check Allis-Chalmers first! Chemical motors are available in all enclosed designs. Shown here are 20-hp motors driving Allis-Chalmers 5 by 4-in. adapter pumps in a mid-western refinery.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5168



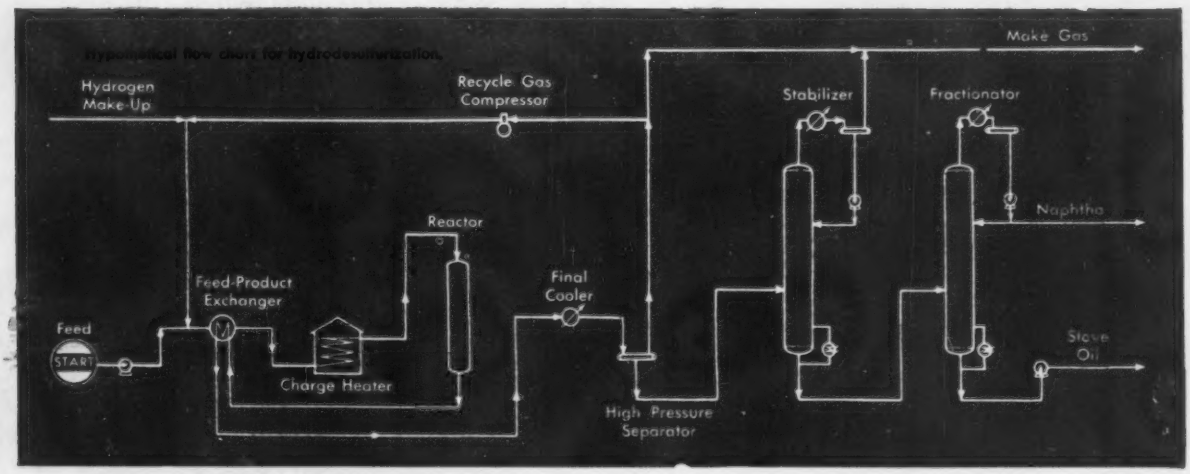
Unifining Unit, Union Oil Company of California refinery, Oleum, California uses Harshaw Cobalt Molybdate Catalyst.

For Hydrodesulfurization

HARSHAW COBALT MOLYBDATE CATALYST

★ **223 regeneration cycles without loss in activity**—a typical performance given by Harshaw Cobalt Molybdate Catalyst, accomplished while treating one of the most difficult charge stocks.

★ **Recording less than 1.0¢/bbl. accumulated costs**—with no indicated loss of activity, Harshaw CO-MO has been full scale tested the longest of any hydrodesulfurization catalyst.



Since you know the critical ingredient of any catalytic hydrogenation reaction is the *catalyst*, the above facts should prompt you to acquire complete details on this premium commodity in the field of catalytic hydrogenation. We shall be happy to point out the many specific advantages that come with using Harshaw Cobalt Molybdate Catalyst and discuss any specific application you may be considering.

Feel free to contact your nearest Harshaw office

HARSHAW

THE HARSHAW CHEMICAL CO.

1945 E. 97th Street • Cleveland 6, Ohio

Chicago
Cincinnati
Cleveland
Detroit
Hastings-On-Hudson, New York
Houston
Los Angeles
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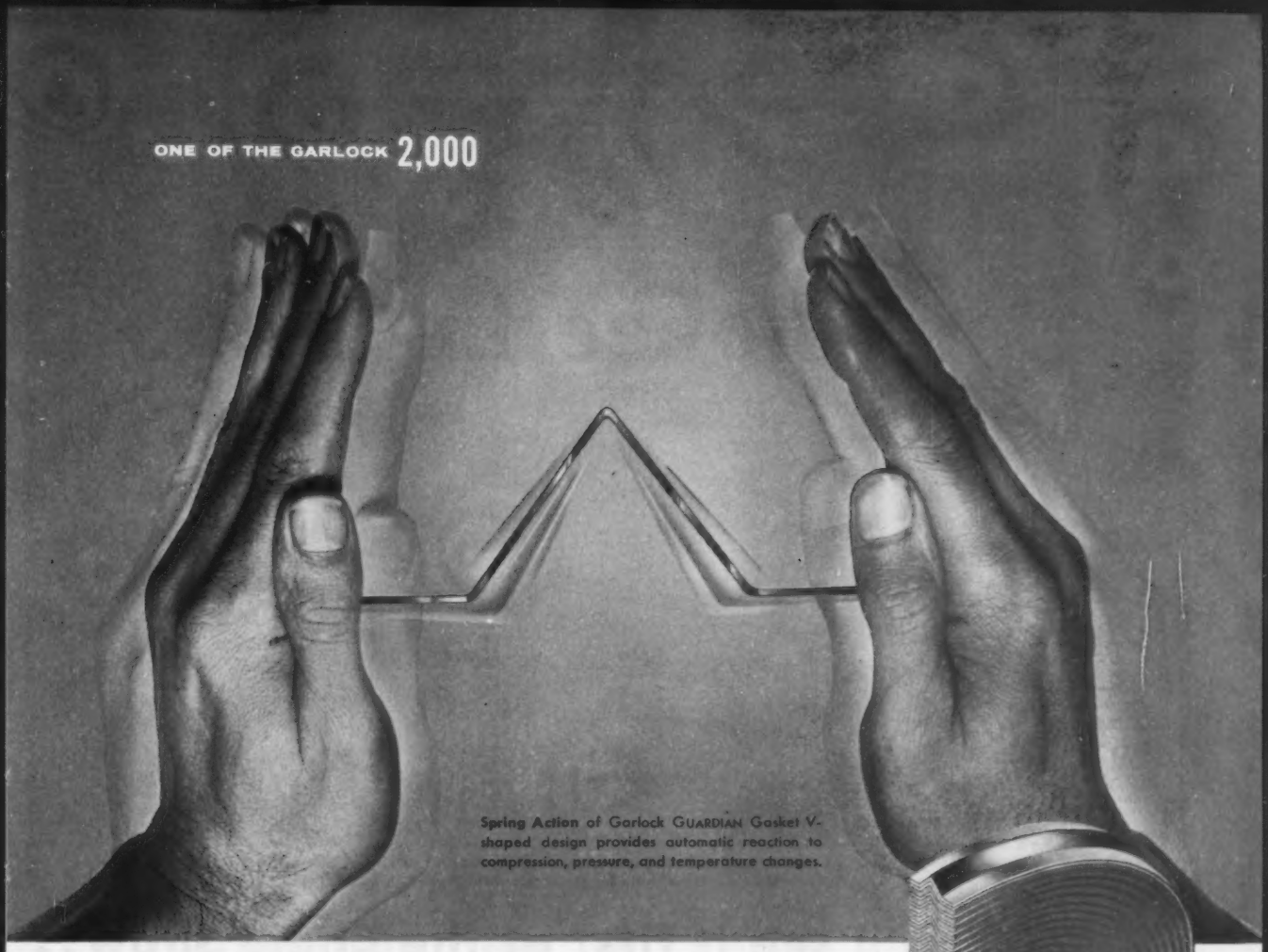
ONE OF THE GARLOCK 2,000



Spring Action of Garlock GUARDIAN Gasket V-shaped design provides automatic reaction to compression, pressure, and temperature changes.

ACCURATELY CONTROL COMPRESSION

WITH GARLOCK SPIRAL WOUND GUARDIAN* GASKETS

Safe, positive sealing at highest temperatures and pressures, and under lighter bolt loads, is assured with Garlock GUARDIAN Gaskets. In no other type gasket can you vary the compressibility to meet different pressure requirements and established bolt loads. This is done by increasing or decreasing the number of layers of metal and asbestos paper (or Teflon). Compressibility can be controlled also by hardness and resiliency of the metal used. 304 stainless steel is used in standard construction. Other types of steel are also available when required. GUARDIAN Gaskets are recommended for use against steam, oils, gases, liquids including most chemicals at temperatures to 1050° F and pressures to 2500 psi.

Garlock GUARDIAN Gaskets are made to Military Specifications and constructed of spiral wound strips of V-shaped metal alternated with layers of asbestos paper or Teflon. The type metal and filler depend upon the application.

GUARDIAN Gaskets are another important part of the famous "Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals to meet all your needs. The *only* complete line. That's why you get unbiased recommendations from your Garlock representative. Call him or write for new GUARDIAN Gasket Catalog AD-104.

*Registered Trademark

THE GARLOCK PACKING COMPANY, Palmyra, N.Y.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products

Corrosioneering News

As soon as you enter the Chem Show, you'll see the new "R" Series Glassed-Steel Reactor. Going down the line you'll see the Wiped-Film Evaporator, Heat Exchanger, Titan Centrifuge, Conical Dryer-Blender.

You'll see it first at the Chem Show..

As soon as you enter the Chem Show you'll see looming above the floor the most advanced reactor design in more than twenty years.

It's one of the new "R" Series of Pfaudler glassed-steel reactors, today's most nearly perfect answer to processing with corrosives.

Come up on our observation platform and study the top head. Note the symmetry of the right and left halves of the top head. On this 1000-gallon reactor there are three *four-inch* nozzles on each half, each at the same angle to a centered eight-inch nozzle and an enlarged 30% manhole measuring 14 by 18 inches.

Neater Installations. Symmetrical heads make for easier, faster, and much more flexible installations . . . particularly when you use tandem hookups. A common pipe, for example, can feed two side-by-side reactors with short, straight lengths. Neater installation, more head room; less piping, too.

We put a special glass on the flange faces of the nozzles, so you can get *lapped* surfaces which permit plumb nozzle connections without time-consuming gasket shimming. These truer gasket facings result in safer operation at *higher* pressures and reduce dangerous seepage which could corrode tank exterior.

Compact Agitator Drive. The new "BH" drive is pedestal-mounted. No cumbersome, space-consuming tripod. The drive takes either seal or stuffing box which can be interchanged at your plant in minutes as single "Pfaudlerpac" unit *without disrupting the drive alignment.*

Higher Jacket Velocity. Reduced jacket clearance permits higher velocity and increased heat transfer.

A new jacket sealer vent is located right on the knuckle radius. Here it gives you almost complete exhaust of entrapped jacket vapors. The vent has a 3000-pound series coupling that takes a lot more punishment than the previous light-gauge coupling.

Drainage. Two more things, before you go downstairs. Look *straight down* through the manhole and you'll see the bottom head outlet. We put it off-center so that it's directly in the sweep path of the agitator. Gives you faster, more complete drainage.

The baffle holder is redesigned, too. New method of support gives larger bearing area and more latitude in adjustments. You can get either fingertip or beaver tail baffles.

Bottom Head Improvements. Lots of changes on the bottom head, too. Notice, for example, there are two three-inch clean-out ports for manual inspection and cleaning. One-and-a-half-inch reducing plates take them down to your pipe connection size. The diaphragm area is all stainless steel for better corrosion resistance.

There's lots more that's new in the exhibit, including these special items:

WIPED-FILM EVAPORATOR

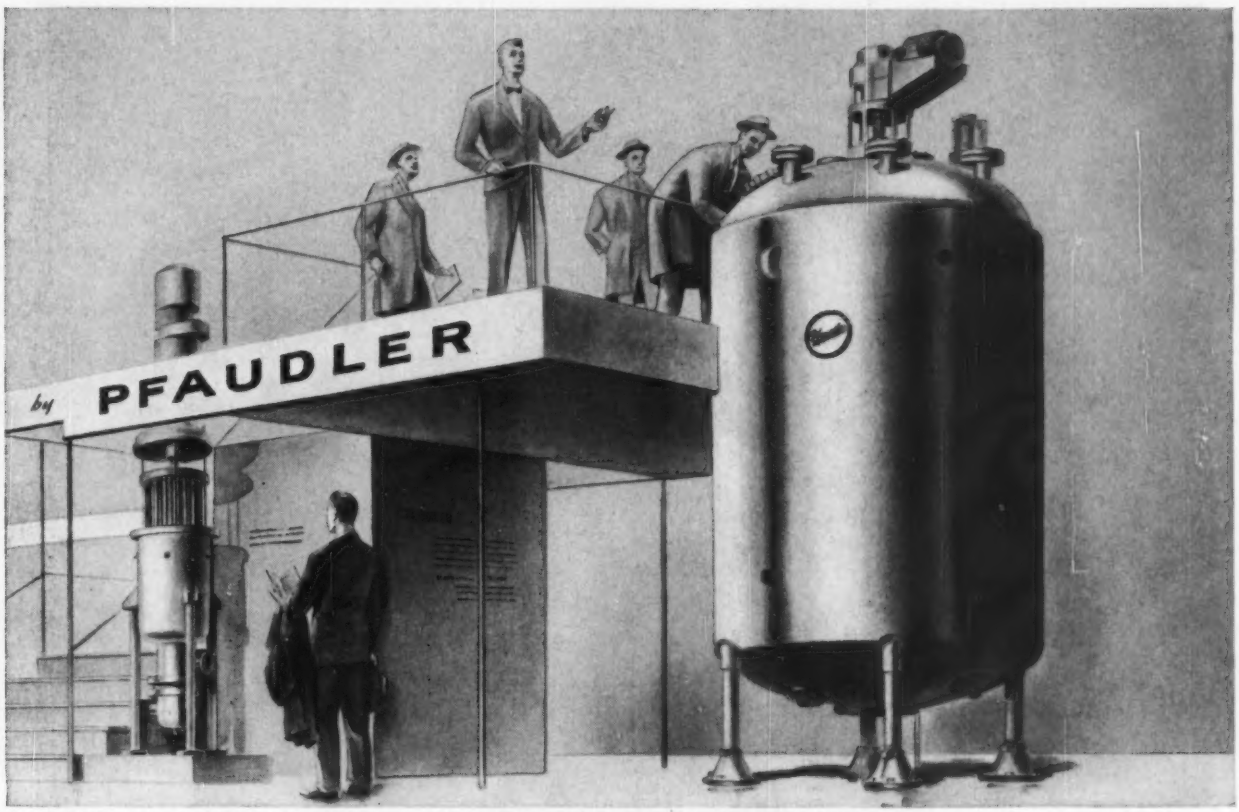
We've lifted the top head of this so that you can see its unique features. The floating carbon blades acted upon by centrifugal force, spread your distillands into very thin, uniform films. These films are wiped over the peripheral evaporating surface. They evaporate quickly because of the high heat transfer rate before they can be damaged through thermal decomposition.

FIXED TUBE HEAT EXCHANGER

You can get a heat exchanger like this delivered to your plant *in just two weeks* from your order date. The tubes are 316 stainless. The shell is carbon steel. Capacities are 56, 104, 149, 216, and 316 square feet.

Even with larger sizes you can get four-to-six-week delivery, since we

For more data on advertised products, use Readers' Service Cards, last page.



On far side of exhibit not shown here, are a Dimple Jacketed Stainless Steel Reactor, a new kind of Dispersion Mill and a "P" Series Kettle with the new "W" Drive. See you at the show, Booths 110 and 141.

. . a completely new "R" Series reactor

stock the various component parts.

There's a lot more information on our flexible standard and custom designs in a bulletin which you can sign up for before you leave.

TITAN CENTRIFUGE

You can operate this centrifuge for as long as a month without shutting down for cleaning. It periodically desludges itself *automatically* while running at top speed.

Just for demonstration purposes, we're feeding a green mixture to the machine. You can see the lighter weight component come out as a clear, yellow liquid, and the heavier component as a clear, blue liquid. Push the button we've provided and watch the centrifuge desludge itself in less than 10 seconds.

This centrifuge works exactly the same with slurries running *up to 35% solids by volume*. It concentrates solids up to 40% dry weight while producing clear effluents. Costs less to run, too.

CONICAL DRYER-BLENDER

This is a glassed steel unit that dries and blends materials simultaneously. One of our customers reports that he cut his drying time from four days to *seven hours* with one of these machines.

Look through the transparent outlet plate and you can see the blending action. The white and red chips inside ride up the side of the drum as it revolves and then cascade down into a homogeneous blend. Notice how much surface area is exposed by this action.

During actual operation the drum is under vacuum, so that liberated vapors are quickly pumped away.

Since the unit is glassed steel you can work with all the acids except hydrofluoric and any alkali below pH 12. Working capacities run up to 165 cubic feet.

PUC MULTISTAGE DISPERSION MILL

Here's a completely new and improved way for wet milling and grinding, homogenizing, dispersing, emulsifying, and extracting.

The mill serves as its own pump, drawing material down through a multistage grinding area to preset sizes and then ejecting the product in either batch or continuous runs. With the pumping action, the mill actually cleans itself. Gives you faster, lower cost production, finer particle sizes, and more stable mixes. Capacities from 44 to 6060 pounds per hour.

If, unfortunately, you aren't attending the show, you can get the literature by checking and sending the coupon below.

THE PFAUDLER CO., a division of PFAUDLER PERMUTIT INC.
DEPT. PR-117, Rochester 3, New York

Please send me: ☐ Bul. 960, "R" Series Reactors ☐ Data Sheet 39, Wiped-Film Evaporators ☐ Bul. 949, Heat Exchangers ☐ Bul. 946, Titan Centrifuges ☐ Data Sheet 26, Conical Dryer-Blenders ☐ PUC Dispersion Mills ☐ Bul. 951 "W" Drives.

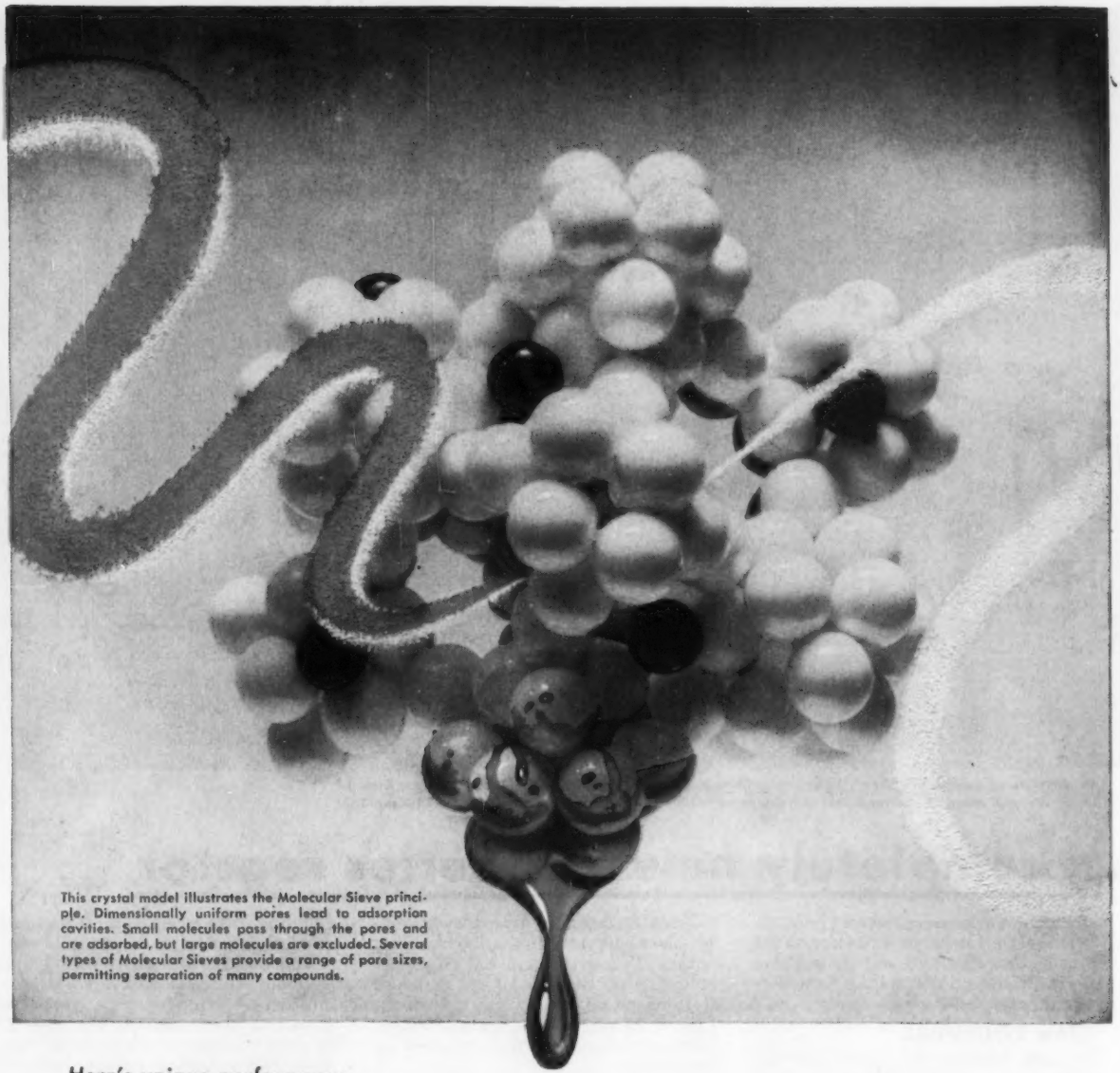
Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....

For more data on advertised products, use Readers' Service Cards, last page.



This crystal model illustrates the Molecular Sieve principle. Dimensionally uniform pores lead to adsorption cavities. Small molecules pass through the pores and are adsorbed, but large molecules are excluded. Several types of Molecular Sieves provide a range of pore sizes, permitting separation of many compounds.

Here's unique performance . . .

Molecular Sieves for Purification and Recovery!

. . . selective removal of contaminants, at temperatures up to 300°F!

. . . selective recovery of valuable stock without regard to relative boiling points!

Molecular Sieves, a new class of adsorbents developed by Linde Company, offer selective separation of gas or liquid mixtures in three ways . . . difference in molecule size . . . or polarity . . . or carbon bond saturation. And, co-adsorption can be utilized to remove several impurities simultaneously.

Typical uses? Removal of catalyst poisons from olefins . . . or extraction of olefins from refinery streams and top gases . . . or simultaneous dehydration and sweetening of natural gas . . . and many, many others.

LINDE Molecular Sieves offer new performance advantages . . . for many production uses. You may be able to lower costs, simplify processes, improve a product with this unique adsorbent. Find out more by writing for data describing Molecular Sieve properties and performance characteristics, **Dept. PR-11,** Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation

Linde TRADE MARK MOLECULAR SIEVES

UNION CARBIDE

one pipe insulation... **UNIBESTOS®**

for every temperature from 80° to 1200° F.

UNARCO

See how you save!

INVENTORIES SIMPLIFIED—only one type of insulation to stock.

EASIEST TO APPLY—standard methods, regular tools; cuts quickly without shattering or end-breakage. Refractory-coated smooth surface.

RESISTS IMPACT—virtually impervious to shock and vibration. Built to stay strong indefinitely.

WITHSTANDS MOISTURE, FUMES—insulating capacity is unchanged by long exposure to various chemical fumes. Submerged in water for weeks, it dries good as new.

POSITIVE HEAT-LOSS PROTECTION — No shrinkage; calcination and dehydration practically eliminated.

LOW THERMAL CONDUCTIVITY—means high insulating efficiency.

HEAT-TIGHT JOINTS—the fibrous nature of Unibestos leads to interlacing between sections for effective heat-sealing of joints.

SINGLE-LAYER APPLICATION—tests prove less heat loss with single-layer UNIBESTOS than with other double-layer insulations.

There's nothing like UNIBESTOS

If you're not using UNIBESTOS now, it's time to take a new look at pipe insulation. Costs come down all along the line with this all-purpose, long-lasting protection.

UNIBESTOS is quickly adapted for flanges, valves, fittings—needs no canvas cover, no additional protection within buildings. Shrinkage is negligible, even at 1200°, and it may be removed and re-used time after time without damage or loss of efficiency.

Long the world's largest selling high-temperature pipe insulation, today's UNIBESTOS is the one *all-temperature* pipe insulation. It costs no more, and only *one* insulation need be stocked on the job.

Small and thin or big and thick, sizes to 44" O.D. Made from long-fibered Amosite asbestos. UNIBESTOS assures outstanding economy, whatever the service or temperature.

HOW THICK SHOULD PIPE INSULATION BE?

Ask for UNARCO'S free 40-page Booklet F76-312 with exclusive "J" Factor Tables for easy, scientific thickness selection according to cost of fuel, hours of operation, life expectancy of installation, pipe size, temperature, and cost of insulating.

UNION ASBESTOS AND RUBBER COMPANY

1111 West Perry Street, Bloomington, Illinois

For more data on advertised products, use Readers' Service Cards, last page.

KEEP IT CLEAN by Phil Tration

"On-the-job" blood purification is not a recommended use for Dollinger Staynew Filters . . . but who knows, maybe our cartoon will start a new trend.

After all, everyone in industry today is looking for new and more efficient ways of doing things. And, when it comes to new ideas in filtration, Dollinger is ready, willing, and able. Whether you want to protect machines or processes from damage caused by dust, dirt, oil, grease, or other foreign matter, Dollinger Engineers will provide a Staynew filter to do the job efficiently and economically. Chances are your filtration problem has already been solved and there is now a *standard* Staynew Filter to handle it.

STAYNEW MODEL ELS LIQUID FILTER

Practically any liquid can be successfully filtered with these Dollinger Filters. Their world-wide use on hundreds of different jobs is adequate proof of their versatility. Any filtering material is available for every problem regardless of temperature, pressure, or efficiency desired. Filter bodies are available in steel, stainless, monel, herculoy and other non-corrosive metals.

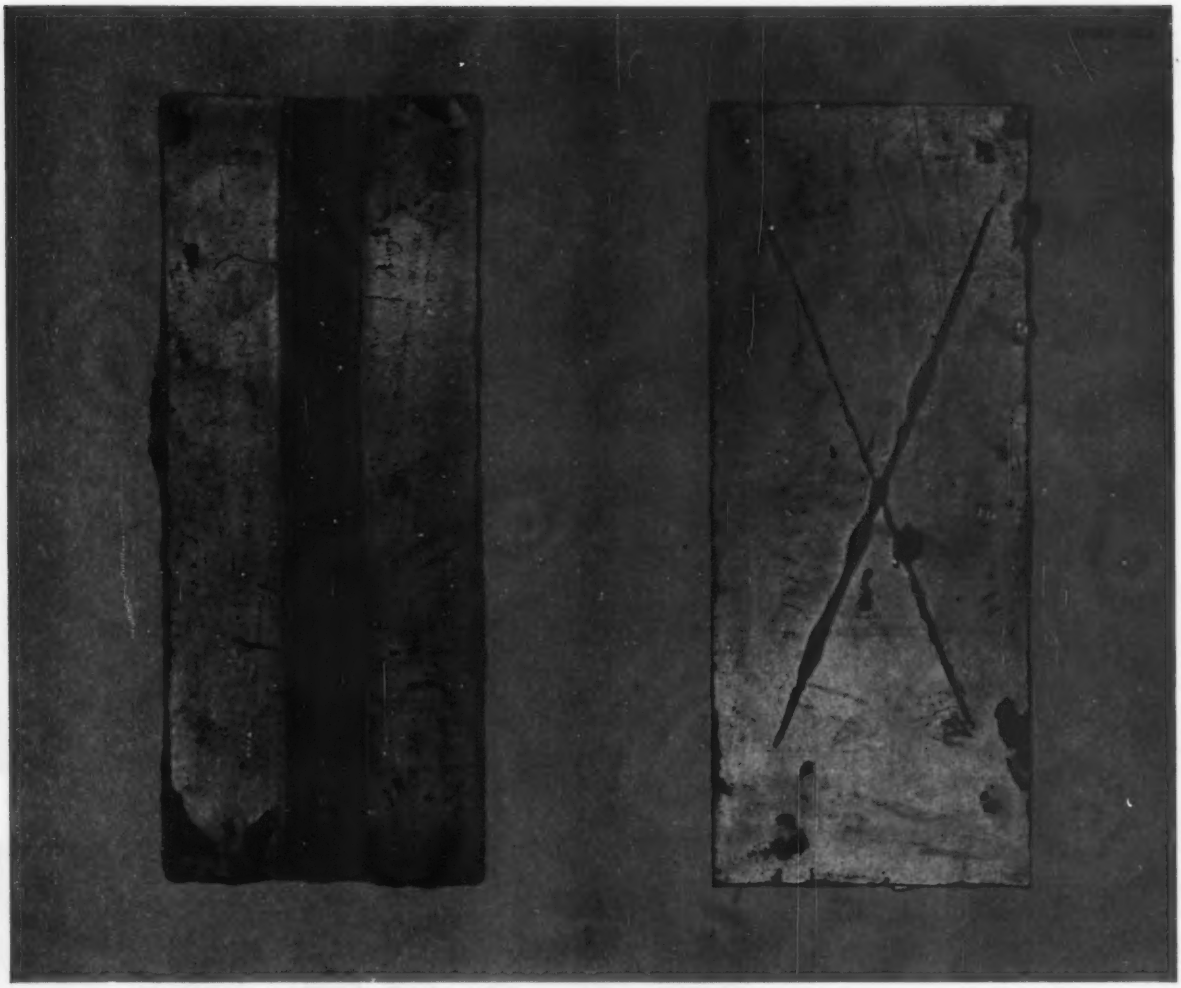
Why not talk your filtration problem over with a Dollinger representative . . . or send for 12-page Bulletin 300. It illustrates and describes Dollinger Liquid Filters and their recommended uses. Dollinger Corporation, 47 Centre Park, Rochester 3, N. Y

PROTECTOMOTOR

STAYNEW DOLLINGER

FILTERS

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS, HIGH PRESSURE FILTERS • AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS



CORROSION'S FOCAL POINTS are easy to detect with a new Amercoat testing method using iron and caustic indicators in a saline gelatin bath. On the welded and scored steel panels shown above after test, unworked surface areas turned red to indicate cathodic properties; but the weld, scores and edges turned blue (here shown blackened) to reveal themselves as anodic corrosion breeders. Rivets, threads, crevices and abrasions also show anodic under test. Unless such areas are effectively sealed from moisture, oxygen and ions they will erupt as focal points of corrosion cells.

How to protect "trouble spots" against corrosion

Ask a corrosion engineer where metal corrosion is likely to attack first. Chances are that he will name rivets, threads, sharp edges, angles, crevices and welds. These are the areas of stress concentration, work hardness, fissures and abrasions. They tend to be anodic and actually breed corrosion. And although they warrant increased protection, conventional coatings pull away from their sharp profiles and leave them inadequately covered.

Amercoat No. 87, a true vinyl mastic, protects these spots in a single coat 10 mils thick, whereas other coatings fail to build 5 mils in three coats. It cuts maintenance painting costs up to 50% because you don't have to re-erect staging and scaffolds for additional coats, and you get results that last.

No. 87 combines the time-tested chemical and weather resistance of vinyl coatings with the thickness of mastic, yet it is easily sprayed with standard equipment over a suitable primer. Available in white, gray, black and aluminum. Use it for enduring protection at lower cost per square foot per year. Complete details mailed on request.—Amercoat Corp., South Gate, Calif.

AMERCOAT Corporation, Dept. VK
4809 Firestone Blvd., South Gate, Calif.

Please send me your latest information on Amercoat No. 87.

Name_____

Position_____

Company_____

Address_____

City_____ Zone_____ State_____

Amercoat® CORPORATION

EVANSTON, ILLINOIS • KENILWORTH, NEW JERSEY
JACKSONVILLE, FLORIDA • HOUSTON, TEXAS

For more data on advertised products, use Readers' Service Cards, last page.

"Used many makes of turbines... PREFERS COPPUS"

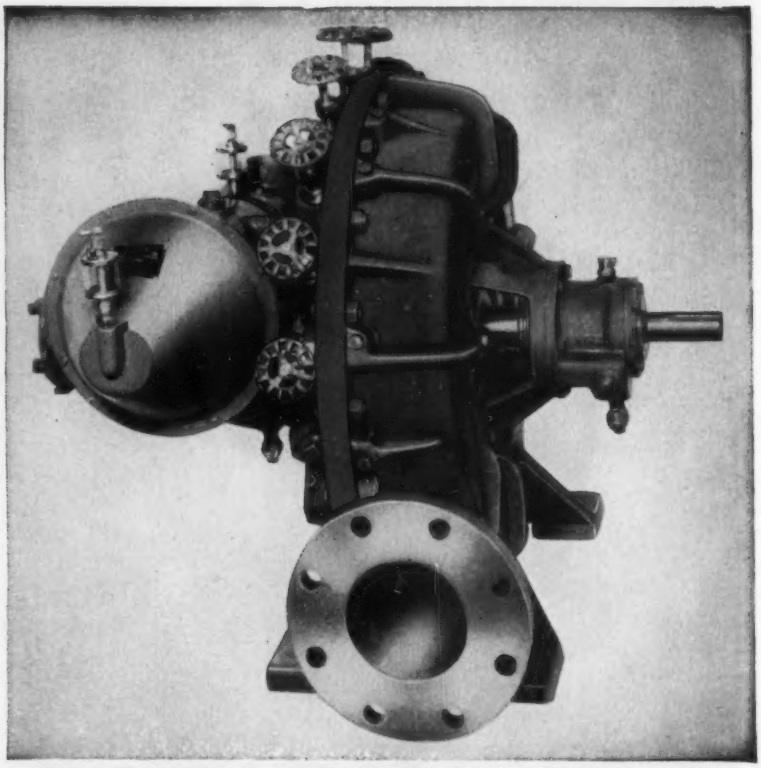
If you want to know about turbine performance, ask an *operator*. He *knows*. And, in the words of one of them:

> "I have had occasion in the past to operate many makes of turbines. The plant in which I am now employed is almost entirely Coppus equipped on our auxiliary equipment. I find your turbines most satisfactory and would like to congratulate you on your design."

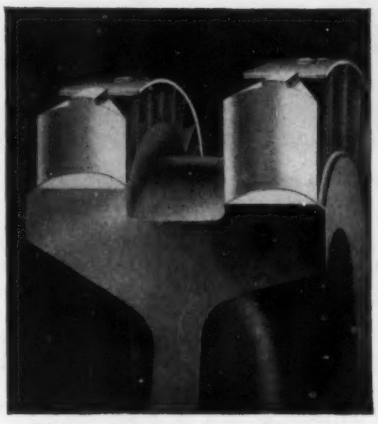
Whether you use a Coppus with a regular wheel or wide bucket "L" type you get these *proven* features:

- Turbines rated close to your hp requirements from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.
- Coppus Steam Turbines ranging from 150 hp down to fractional in 6 frame sizes, *make turbine dollars go farther*. Send for Bulletin 135 on Coppus Turbine.

COPPUS ENGINEERING CORPORATION
424 Park Avenue, Worcester 2, Mass.
Sales offices in THOMAS' REGISTER



This is the reliable Coppus Turbine furnished with either a regular wheel or wide bucket "L" type wheel.



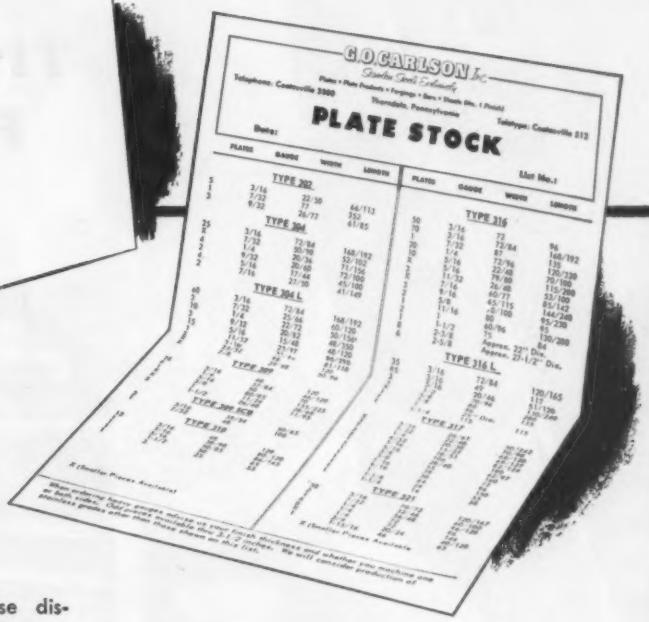
This wide bucket "L" type wheel is a new development for use where low water rate is essential

This is the regular wheel used on Coppus Turbines which have been so highly satisfactory throughout industry.

COPPUS "BLUE RIBBON" TURBINES

Keep up to date...

on Stainless Steel Plates and Heads



Carlson's Weekly Stock Lists tell you what you want to know:

- the Type, Gauge, Width and Length of stainless steel plates in stock.
- the Type, Gauge and Size of stainless steel heads in stock.
- the sales representatives and warehouse distributors in this country and Canada who are ready to serve you.

YOU can save time by checking these weekly stock lists. Here is an up-to-the-minute report on our large, diversified stock of stainless steel plates and heads that have been produced especially for chemical industry applications.

Carlson plates in Types 304-L, 316-L and 317-L are more and more in demand. Substantial stocks of these extra-low-carbon grades, along with other chromium-nickel Types 302, 304, 309, 309-S, 310, 316, 317, 321, 347 and 348 are available. Chromium grades 405, 410, 430 and 502-½% Mo are always in stock. Two precipitation-hardening grades, Types 17-4 PH* and 17-7 PH*—new plate grades that combine ease of fabrication, hardenability, high strength and corrosion resistance—are now in production and limited stocks are carried. To complete the story, stainless steel heads in Types 304, 304-L, 316 and 316-L are also stocked and can be shipped in a few days.

Make Carlson your *one-stop* source for that complete bill of material—stainless steel plates, heads, rings, circles, flanges, forgings, bars and sheets (No. 1 Finish).

When you need stainless plate . . .

Carlson gives you what you want when you want it!

*Trade Mark of ARMCO STEEL CORPORATION

G.O.CARLSON Inc.

Stainless Steels Exclusively

THORNDALE · PENNSYLVANIA

District Sales Offices in Principal Cities

G. O. CARLSON, INC.
136 Marshalton Road
Thorndale, Pennsylvania

Write for your copies of Carlson's Weekly Stock Lists . . . use this convenient coupon.

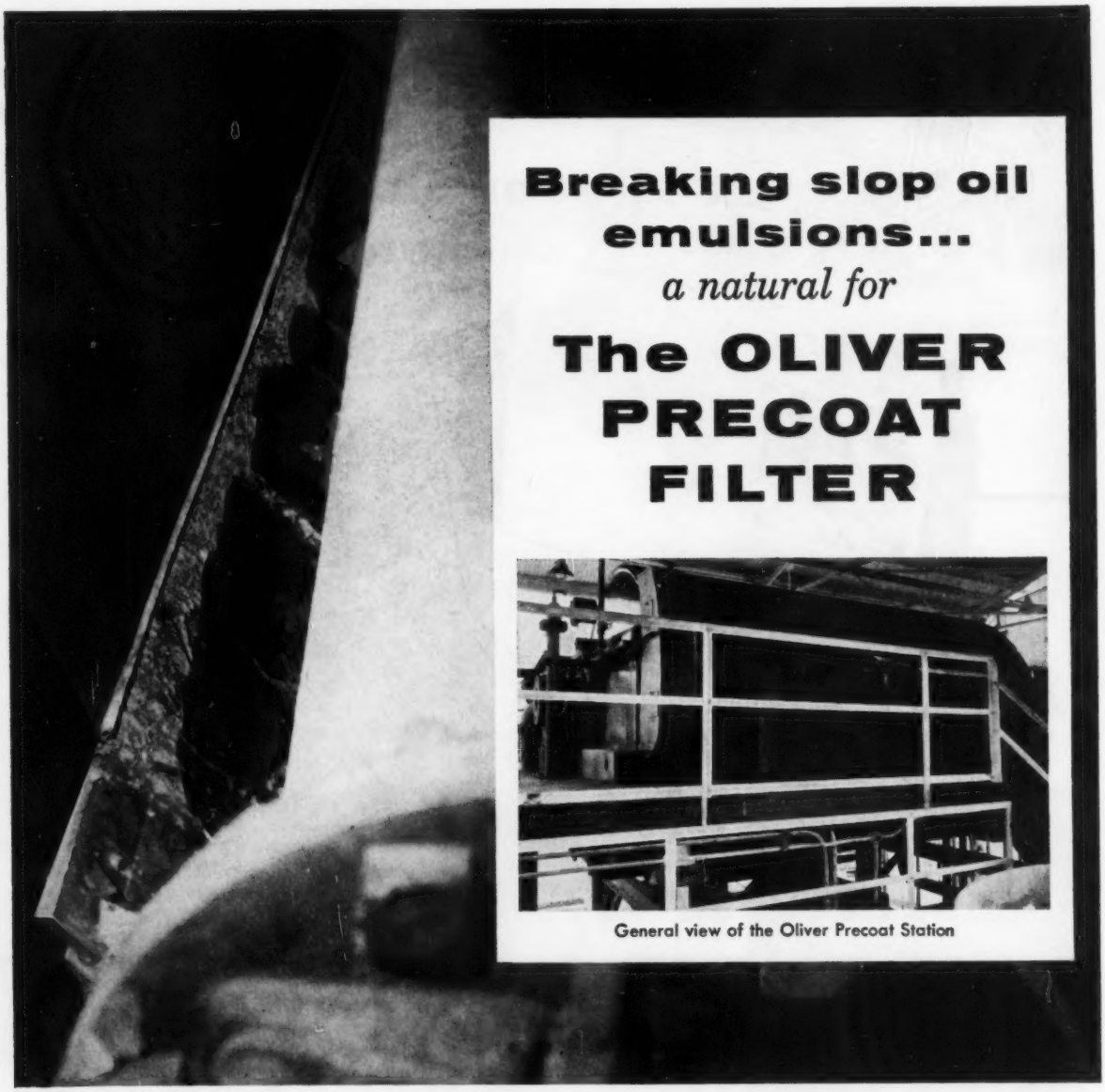
Name:.....

Company:.....

Address:.....

City:..... State:.....

For more data on advertised products, use Readers' Service Cards, last page.



Breaking slop oil emulsions...

a natural for

The OLIVER PRECOAT FILTER

General view of the Oliver Precoat Station

Closeup of knife edge discharger clearly showing thin film of precoat and cake being continuously removed.

Recently installed at a large Southwestern Refinery, is another Oliver Precoat Filter for the handling of refinery slop oils.

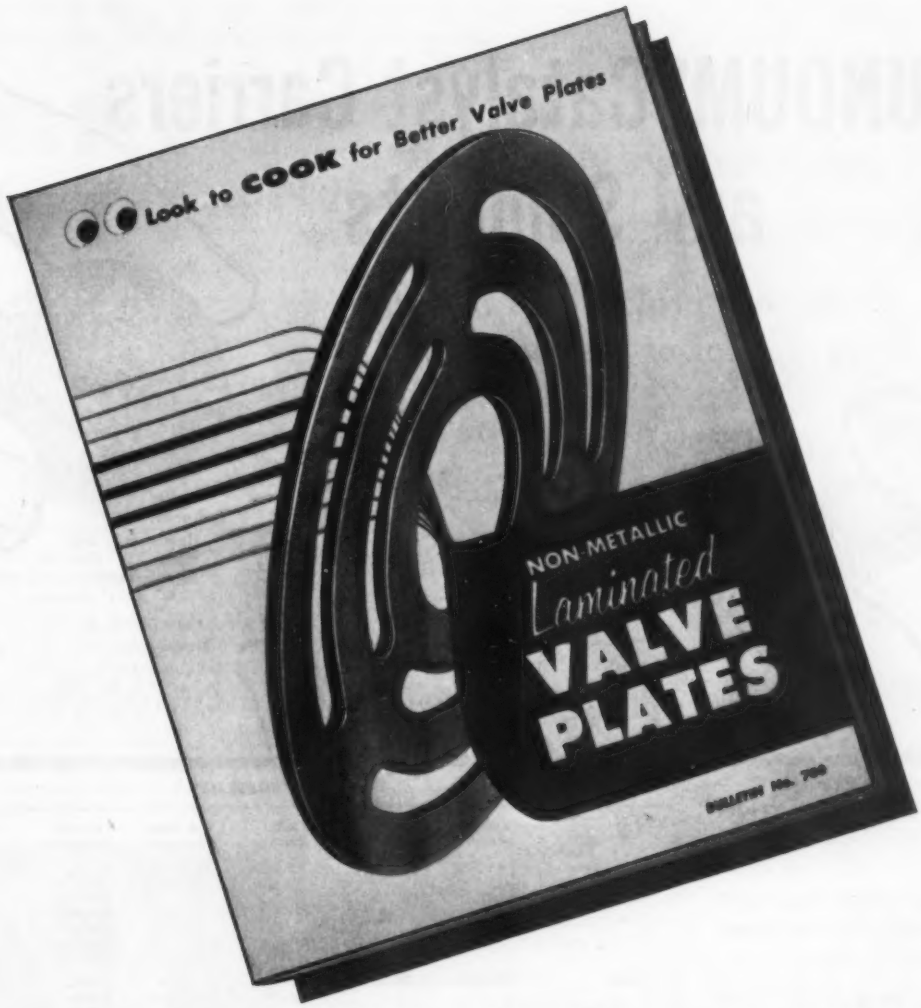
The problem . . . continuous and economical removal of colloidal solids such as clay, coke, carbon, catalyst and some chemical emulsifiers from refinery slop oils thus permitting the separation of oil and water.

The Oliver Precoat Filter handles this heretofore considered "difficult to filter" material and delivers a filtrate which readily separates into oil and water phases.

Dorr-Oliver manufactures a complete line of filters — batch and continuous, for the petroleum industry. For more information on Oliver Petroleum Filters, write Dorr-Oliver Incorporated, Stamford, Conn.

DORR-OLIVER
INCORPORATED
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT
STAMFORD • CONNECTICUT • U.S.A.

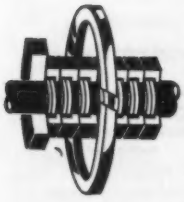
For more data on advertised products, use Readers' Service Cards, last page.



Send for this informative new bulletin today!

Cook Bulletin No. 700, *"Non-Metallic Laminated Valve Plates"* is now off the press. It contains up-to-date facts on the when, why and where of non-metallic valve plates—plus helpful data on applications, delivery and special materials. It also explains how Cook laminated valve plates are different from competitive brands, and *why* they are better.

USE THE COUPON FOR YOUR FREE COPY, TODAY!



C. LEE COOK COMPANY
Division of Dover Corporation

Rings and Packings Since 1888

C. Lee Cook Company
950 South Eighth Street
Louisville 3, Kentucky

Gentlemen: Without obligation please send a copy of Bulletin No. 700.

Company_____

Street_____

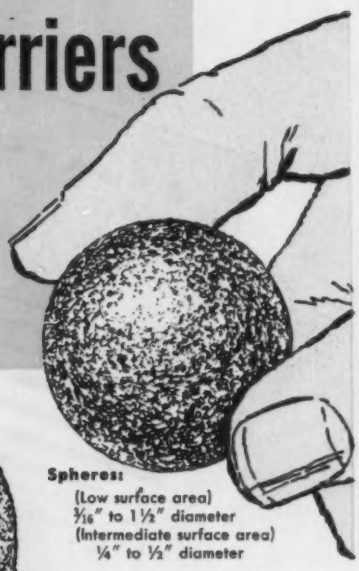
City_____ State_____

Att. Mr._____ Title_____

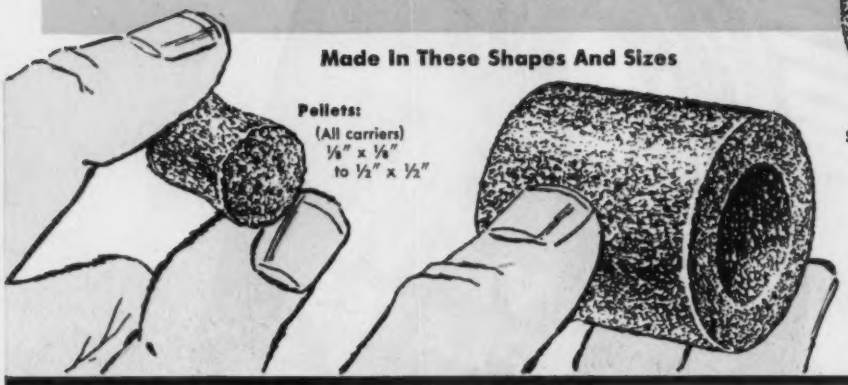
For more data on advertised products, use Readers' Service Cards, last page.

ALUNDUM* Catalyst Carriers and Supports

are proved aids to better, lower cost processing



Made In These Shapes And Sizes



Pellets:
(All carriers)
⅛" x ⅛"
to ½" x ½"

Spheres:
(Low surface area)
3/16" to 1½" diameter
(Intermediate surface area)
¼" to ½" diameter

Rings:
(All carriers)
⅛" x ¼" to ⅜" O.D.
to 1" x 1½" x 1½" O.D.

Norton ALUNDUM catalyst carriers have excellent mechanical, thermal and chemical stability. They are crystalline in nature and are produced in two surface area types: Intermediate (5-70m²/gram) and Low (less than 1m²/gram).

The alumina content of the intermediate carriers is approximately 77%. These are subdivided into Types A, B and C, with varying characteristics. In the low surface area carriers, the alumina content ranges from 77% to 92%.

PHYSICAL PROPERTIES

	Apparent Porosity	Water Absorption	Bulk Density	Vol. Bulk Density	Crystal Structure	Surface Area
Intermediate Surface Area Type A	45-50%	28-30%	.65-1.70 gr/cc	58 lbs/ft³ (Approx.)	Quartz, Alpha, Gamma Alumina — chiefly Gamma Alumina	60-70m²/gram
Type B	45-50%	28-30%	1.65-1.70 gr/cc	60 lbs/ft³ (Approx.)	Quartz, Alpha, Kappa, Delta Alumina	20-30m²/gram
Type C	45-50%	28-30%	1.65-1.70 gr/cc	62 lbs/ft³ (Approx.)	Alpha Alumina and Mullite	5-10m²/gram
Low Surface Area	10-50%	3-25%	1.90-3.15 gr/cc	65-80 lbs/ft³	Alpha Alumina and Mullite	Less than 1m²/gram

Some Of Many Applications

Suggested Applications For Intermediate Surface Carriers include catalytic reforming, dehydrogenation, dehydration, sulfuric acid manufacture, nitric acid manufacture and dessicants.

Low Surface Area Carriers are used in the processing of phthalic anhydride, maleic anhydride and ethylene oxide; also in protective atmospheres and synthetic gas generation.

Suspending Active Catalysts Effectively

In fixed bed convertors where it is necessary to suspend active catalysts at a given level, supports produced by Norton are used successfully. Made of dense, rugged, electrically fused materials these supports have great resistance to breakdown and have no chemically reactive effect on the processing.

Get More Facts

on how Norton catalyst carriers and supports can improve and economize your processing. On request, they can be prepared from other materials such as: CRYSTOLON* silicon carbide, MAGNORITE* fused magnesia, zirconium oxide, silica, etc. Call in your Norton Refractories Engineer or write, mentioning your requirements, to NORTON COMPANY, Refractories Division, 471 New Bond St., Worcester 6, Massachusetts.

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed
Making better products... to make your products better

NORTON PRODUCTS:
Abrasives • Grinding Wheels
Grinding Machines • Refractories
BEHR-MANNING PRODUCTS:
Coated Abrasives • Sharpening Stones
Behr-cat Tapes
*Trade-Marks Reg. U.S. Pat. Off. and Foreign Countries

For more data on advertised products, use Readers' Service Cards, last page.

BRIEFS
for caustic soda buyers

New booklet
Barge delivery
Flake sizes
Drum styles

Useful facts on buying caustic soda are at your fingertips in this new pocket-size booklet.

Title: *Caustic Soda Buyer's Guide.*

Contents include a list of reasons *pro* and *con* switching from 50% to 73% liquid caustic.

There's a factual discussion of the comparative economics of both strengths, including a handy nomograph to help you figure which strength is your better buy.

The booklet also contains a nomograph that helps you estimate your liquid caustic requirements for various process solutions.

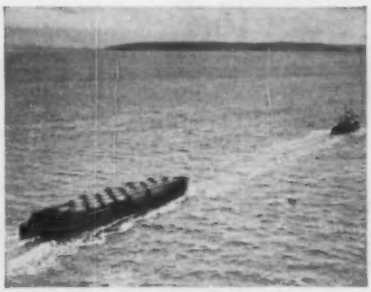
There's information on solid and flake caustic, too. Two tables show at a glance the dimensions and capacities of the many containers in which you can buy Hooker caustic soda.

Finally, there's a list of important points to consider when you're looking for a caustic soda supplier.

Check the coupon at right for a copy. Or write us if you'd like more than one.

Can you save buying by barge?

If you use large tonnages of 50% liquid caustic soda, and can receive by water, you may cut freight and handling costs substantially with barge service.

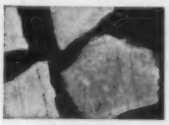


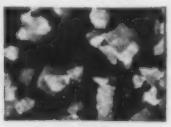
All Hooker plants and caustic terminals offer barge service as well as tank car service, since all are located on deep water.

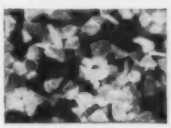
If you think there's a possible saving here, one of our representatives will be glad to discuss barge delivery with you.

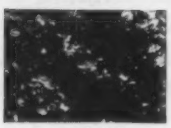
Which flake size? It's easy to be sure of the best possible caustic soda flake size for your process, when you buy Hooker caustic.

You have your choice of the four sizes here—all shown actual size.


REGULAR


FINE


CRYSTAL


GRANULAR

Regular, fine, and *crystal* flake are non-dusting—carefully screened for uniformity. We're extra-fussy about flake *thickness,* too. These flakes are hefty enough to take the jolts and jouncing of transit, and still reach you at full size. Yet they're thin enough to dissolve quickly when you're ready to put them to work.

For advice on the best flake size for your needs, write us, outlining the intended use.

You can empty this caustic soda faster. Whether your operators scoop, pour, or shovel flake caustic soda, they will find this new Hooker drum easier, faster, and safer to work with.

The opening on this new drum is a full 18 inches in diameter—an increase of 65% in opening area. When the drum is inverted, caustic can't pile up around the inside as it does with other standard drums.

You pay no more for this extra convenience. To get it, just specify Hooker caustic soda in the 18-inch-opening drum.

Check items you'd like to receive:

- ☐ *Caustic Soda Buyer's Guide*

Technical data on:

- ☐ 50% Liquid Caustic Soda
- ☐ 73% Liquid Caustic Soda
- ☐ Flake Caustic Soda

For information on these other Hooker chemicals used in the petroleum industry, check below:

- ☐ Antimony Trichloride
- ☐ Muriatic Acid
- ☐ Sulfur Monochloride
- ☐ Sulfur Dichloride

Clip and mail to us with your name, title, company address.

HOOKER CHEMICALS PLASTICS

HOOKER ELECTROCHEMICAL COMPANY
1611 FORTY-SEVENTH STREET, NIAGARA FALLS, N. Y.

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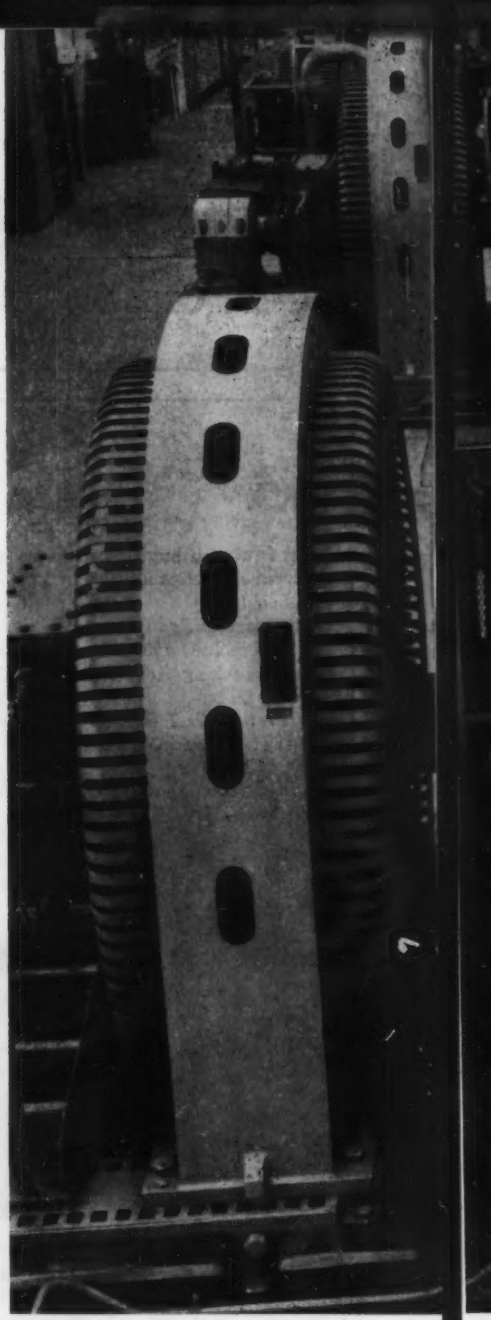


Two 1500 hp motor-driven JM compressors handling compression of synthesis gas, before conversion to ammonia.

In Ammonia Service for U.S.I....

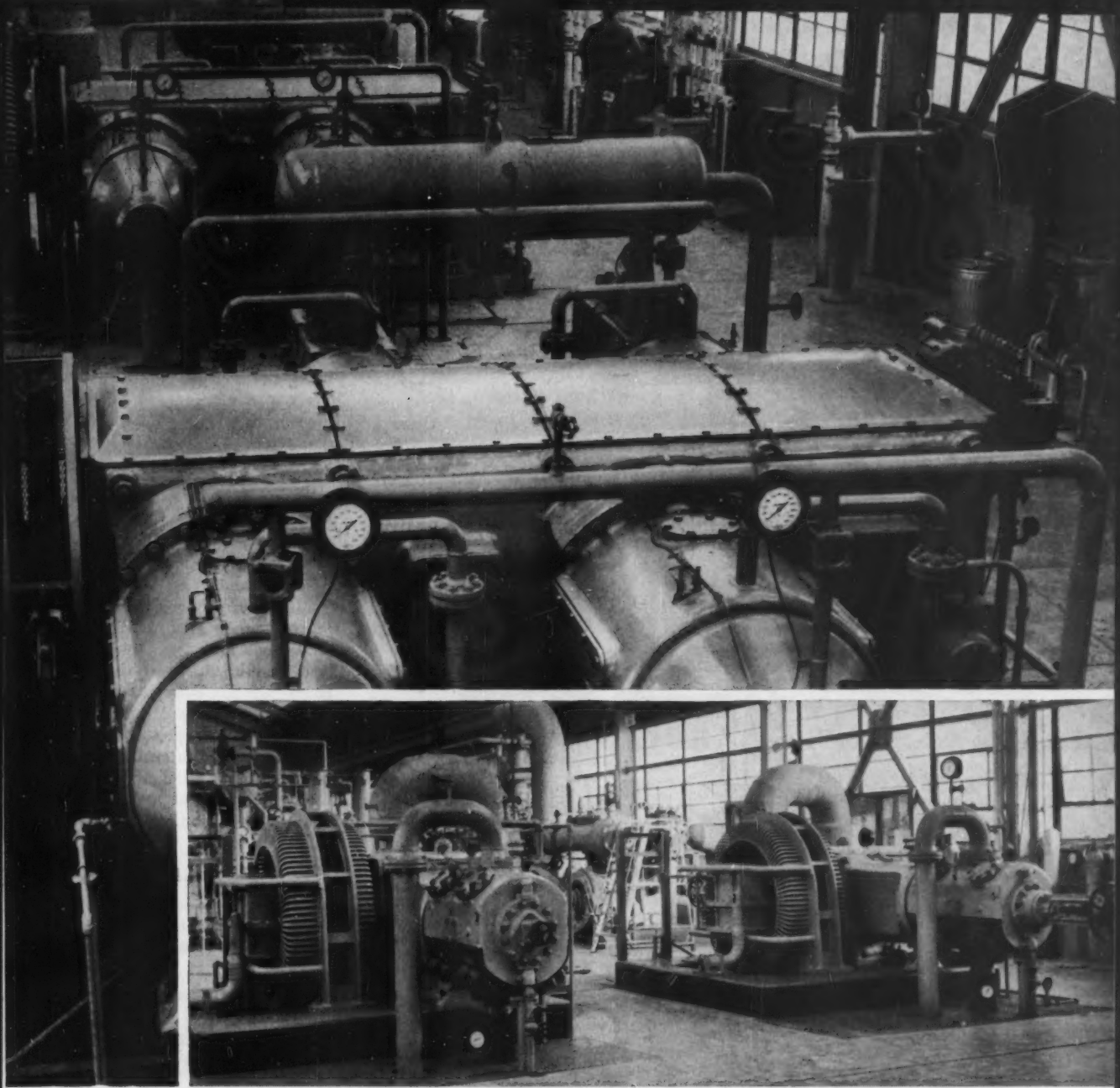
high efficiency Cooper-Bessemer Compressors

This installation at the Tuscola, Illinois plant of U. S. Industrial Chemical Co., a division of National Distillers and Chemical Corp., is typical of the many processing plants using reliable Cooper-Bessemer compressors.

Here, two 4-cylinder JM compressors, each rated 1500 hp, handle compression of synthesis gas; and two 2-cylinder FM compressors, each rated 300 hp, handle the compression of ammonia.

These modern, natural force balance Cooper-Bessemers retain the long-life qualities of much larger slow speed units. The M-Line is exceptionally compact without sacrificing accessibility or ruggedness. They conserve valuable space, reduce over-all installation time, and require less investment in foundations and piping.

Available from 200 to 6000 horsepower, each M-Line compressor unit is engineered to meet specific requirements with extreme efficiency and at the lowest possible cost. The nearest Cooper - Bessemer office will gladly furnish detailed information.



Cooper-Bessemer 2-cylinder FM's compressing ammonia at the Tuscola plant of U. S. Industrial Chemical.

Cooper/Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS • DIESEL • GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE OR MOTOR DRIVEN

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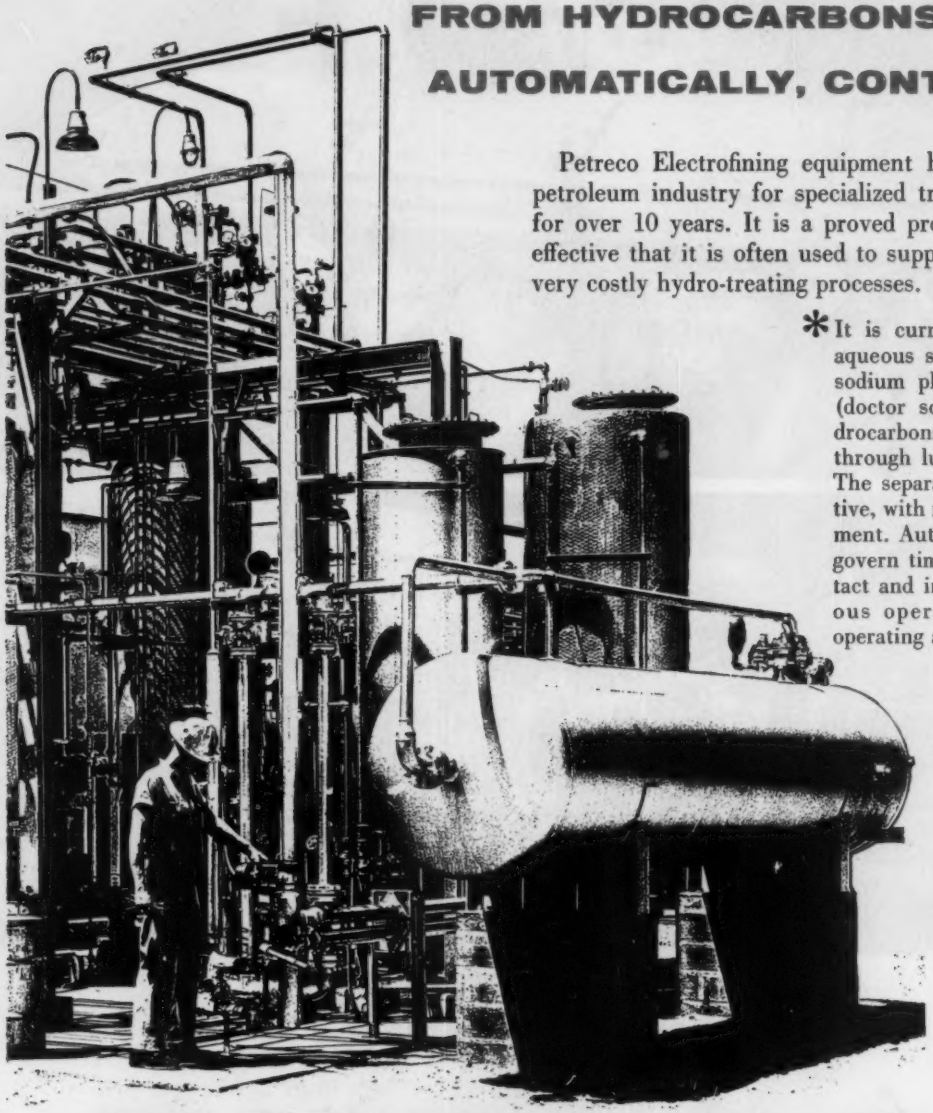
do you have a separation problem?

PETRECO ELECTROFINING EQUIPMENT SEPARATES AQUEOUS-CHEMICAL SOLUTIONS* FROM HYDROCARBONS QUICKLY, AUTOMATICALLY, CONTINUOUSLY



Petreco Electrofining equipment has been used in the petroleum industry for specialized treating of light stocks for over 10 years. It is a proved process, so efficient and effective that it is often used to supplement or replace the very costly hydro-treating processes.

*It is currently used to separate aqueous solutions of acid, alkali, sodium plumbite-caustic solution (doctor solution) from light hydrocarbons ranging from gasoline through lubricating oil distillates. The separation is rapid and positive, with minimum or nil entrainment. Automatic, pre-set controls govern time and intensity of contact and insure efficient, continuous operation with minimum operating attention.

For complete information write for **FREE BULLETIN**

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A DIVISION OF PETROLITE CORPORATION

3202 S. Wayside Drive, Houston 1, Texas • 1390 East Burnett St., Long Beach 7, California

Specialized Electric Petroleum Treating

DESALTING • DEHYDRATING • CAUSTIC WASHING • ACID TREATING • DOCTOR TREATING • SWEETENING • NAPHTHENIC ACID REMOVAL • SEDIMENT REMOVAL

PP 57-1

He Builds with SWECO

When this oil man needed a new refinery he faced a basic question: *How to get the best design and construction at lowest capital investment?* SWECO's answer made him a life-long client.

To build a new refinery for his supply of crude, he investigated many engineering and construction companies. One, he found, was just the right size: Not so big that his medium-size installation would get lost behind vast projects. But big enough to provide complete service. The picture was perfect: personal attention from a seasoned staff.

He investigated SWECO

SWECO engineering teams had designed and built complete refineries and refinery additions all over the world. They were licensed to engineer and construct plants for most modern refining processes. SWECO jobs, he found, were brought in on-target – regardless of location, weather, untrained labor or earth-girdling supply lines. And SWECO's reputation in the design and manufacture of petroleum processing equipment meant valuable knowledge and control of sources of supply.

He invited SWECO's proposal

Ingenuity and know-how were evident in every page of the SWECO proposal. It included field surveys and soil tests. Economic analyses and market studies. A provisional flow sheet showed the entire process graphically. Specifications, schedules, and plans were spelled out in detail. The proposal was wrapped up with a complete feasibility report.

He turned the job over to SWECO

From engineering and design, through purchasing and expediting, field construction – even through training personnel and putting the plant into operation–the SWECO engineering team took full responsibilty. It was a typical SWECO job: on-stream on-schedule. Now, the oil man is a typical SWECO client. Whatever his engineering and construction needs – complete plants or additional units for an existing installation – he builds with SWECO.

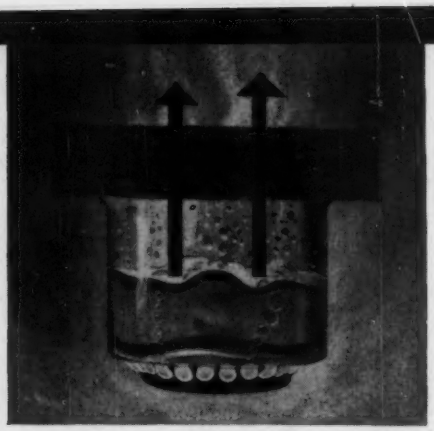
For the story on what SWECO *Engineering and Construction teams can do for you in building refineries or petro-chemical plants . . . write for Bulletin E-7-333.*

SWECO

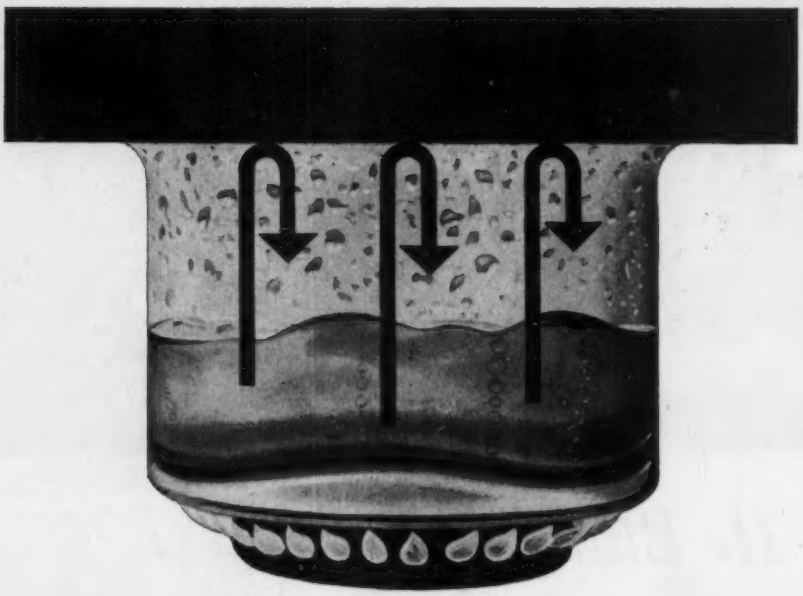
Southwestern Engineering Company

4800 Santa Fe Avenue • Los Angeles 58, California

Engineers and Constructors . . . Manufacturers



Some insulations transmit vapor



FOAMGLAS®

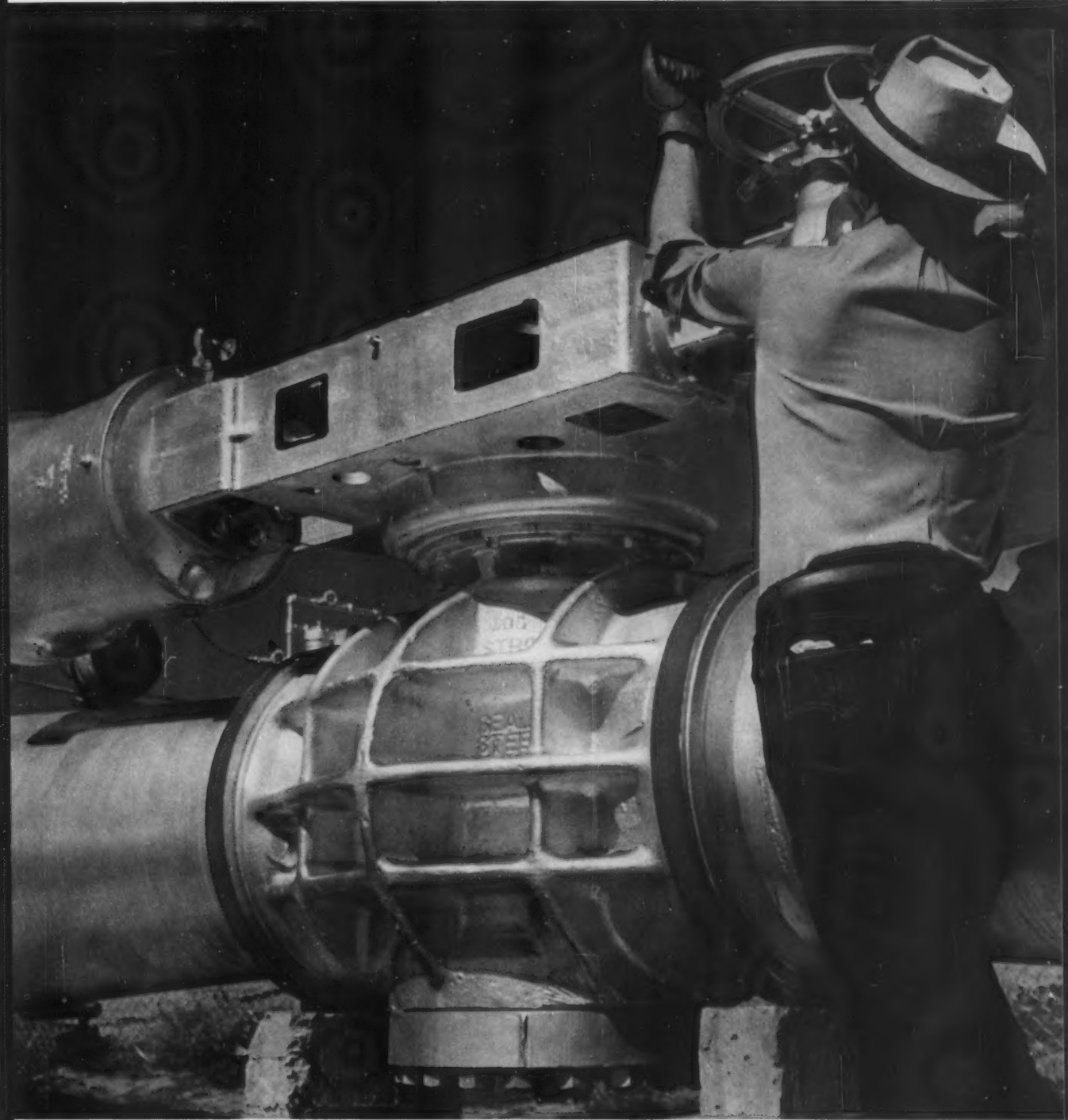
INSULATION

is vapor-proof . . .

needs no separate vapor barrier!

—and inorganic FOAMGLAS is dimensionally stable . . . waterproof . . . easily carries loads of 7 tons per sq. ft. . . . can't burn . . . repels all vermin . . . easy, economical to handle and install. Write for detailed literature.

®Pittsburgh Corning Corporation
Dept. Z-117 One Gateway Center, Pittsburgh 22, Pa.
In Canada: 57 Bloor Street West, Toronto, Ontario



EMERGENCY! Are you sure your key valves will operate when an emergency comes? They will, *if* they are Rockwell-Nordstrom valves with *pressurized lubrication* that makes operation fast, easy and *sure*.

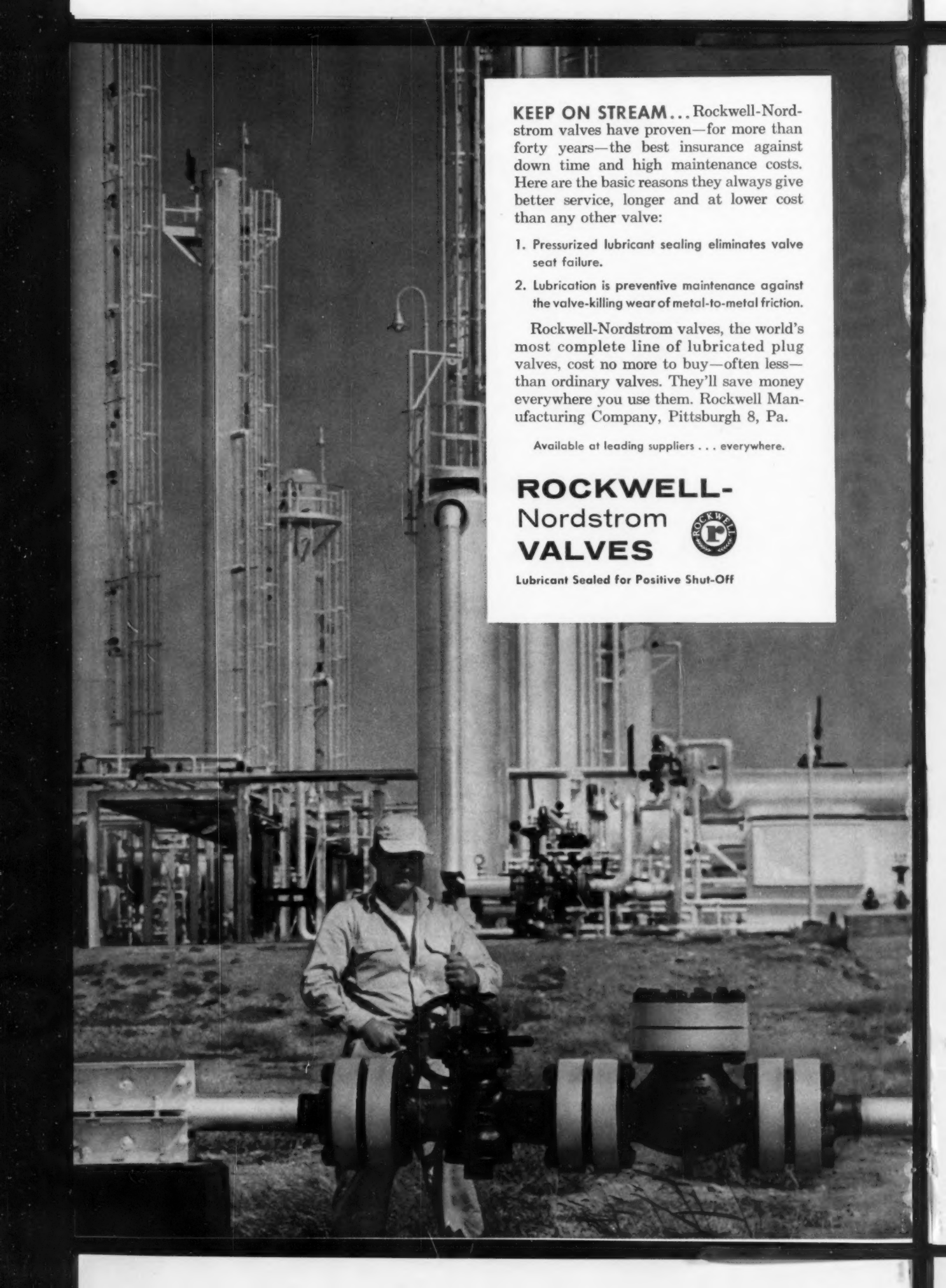
Unlike the forced seating in ordinary valves, the Rockwell-Nordstrom valve plug is kept friction-free by lubricant—frozen or stuck valves are eliminated. And quarter-turn closure is two to five times faster.

The lubricant in Rockwell-Nordstrom valves does another important job: it eliminates metal-to-metal wearing friction for longer valve life. Yet with all their obvious advantages, Rockwell-Nordstrom valves cost no more to buy, often less, than ordinary valves. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Available at leading suppliers . . . everywhere.

ROCKWELL-
Nordstrom
VALVES

Lubricant Sealed For Positive Shut-Off



KEEP ON STREAM... Rockwell-Nordstrom valves have proven—for more than forty years—the best insurance against down time and high maintenance costs. Here are the basic reasons they always give better service, longer and at lower cost than any other valve:

1. Pressurized lubricant sealing eliminates valve seat failure.
2. Lubrication is preventive maintenance against the valve-killing wear of metal-to-metal friction.

Rockwell-Nordstrom valves, the world's most complete line of lubricated plug valves, cost no more to buy—often less—than ordinary valves. They'll save money everywhere you use them. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Available at leading suppliers . . . everywhere.

ROCKWELL-
Nordstrom
VALVES

Lubricant Sealed for Positive Shut-Off

If you could lift the covers . . . you'd find BALDWIN-HILL MONO-BLOCK® and SUPER POWERHOUSE® CEMENT

insulating every vessel heated to 600° F. and over . . . covering all insulated surfaces more than 24″ in diameter at

Tidewater Oil Company's New Delaware Refinery

A trainload of 50 cars—over 1,000,000 bd. ft.—of B-H Mono-Block helps prevent costly heat losses and permits better control of operating temperatures. By standardizing on Mono-Block, C. F. Braun Co., Engineers and Constructors, saved stocking separate blocks for both low and high temperatures since Mono-Block is efficient over all temperatures from 75° to 1700° F. B-H Super Powerhouse Cement was used to point all joints and, where required, was applied in a single coat as an insulating-finishing cement.

BALDWIN-HILL COMPANY

Complete line of Industrial Insulations

711 Breunig Avenue • Trenton 2, N. J.

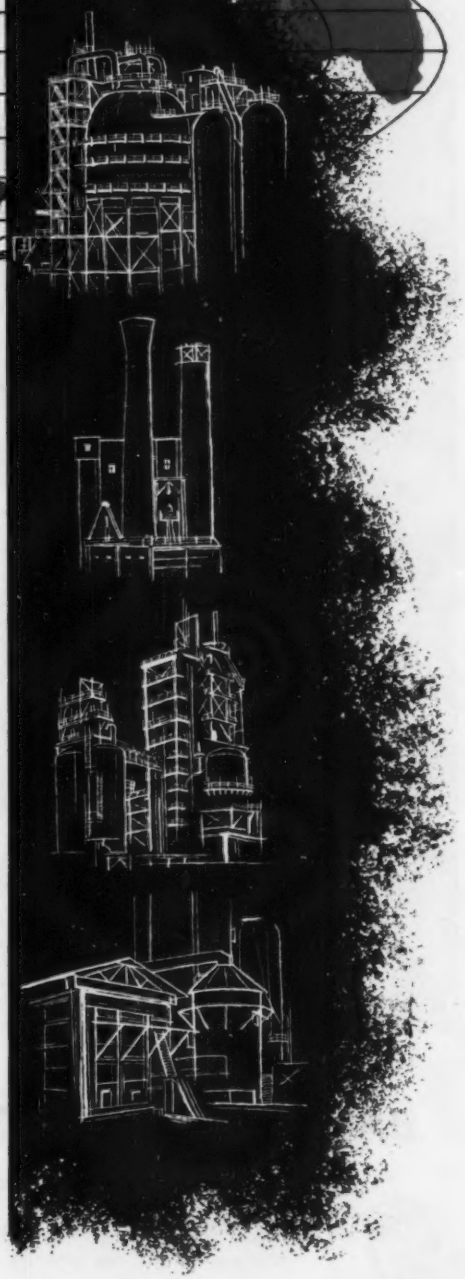
Kalamazoo, Mich. • Huntington, Ind. • Temple, Texas

For a detailed report on the insulation of this economical installation, just staple the keyed corner of this ad to your letterhead and mail.

J-375

For more data on advertised products, use Readers' Service Cards, last page.

THROUGHOUT THE WORLD...



Serves the Petroleum Refining Industry with a Complete Line of High Quality Refractory Products

The petroleum industry, throughout the world, relies on A. P. Green high quality refractories for dependable service in thermal and catalytic cracking units, heaters, boilers, stacks, et cetera.

A world-wide network of A. P. Green distributors with engineers experienced in petroleum refining is always ready to help you select the right refractories to do the best possible job . . . at the lowest cost. For one dependable source of a complete line of refractories write . . .

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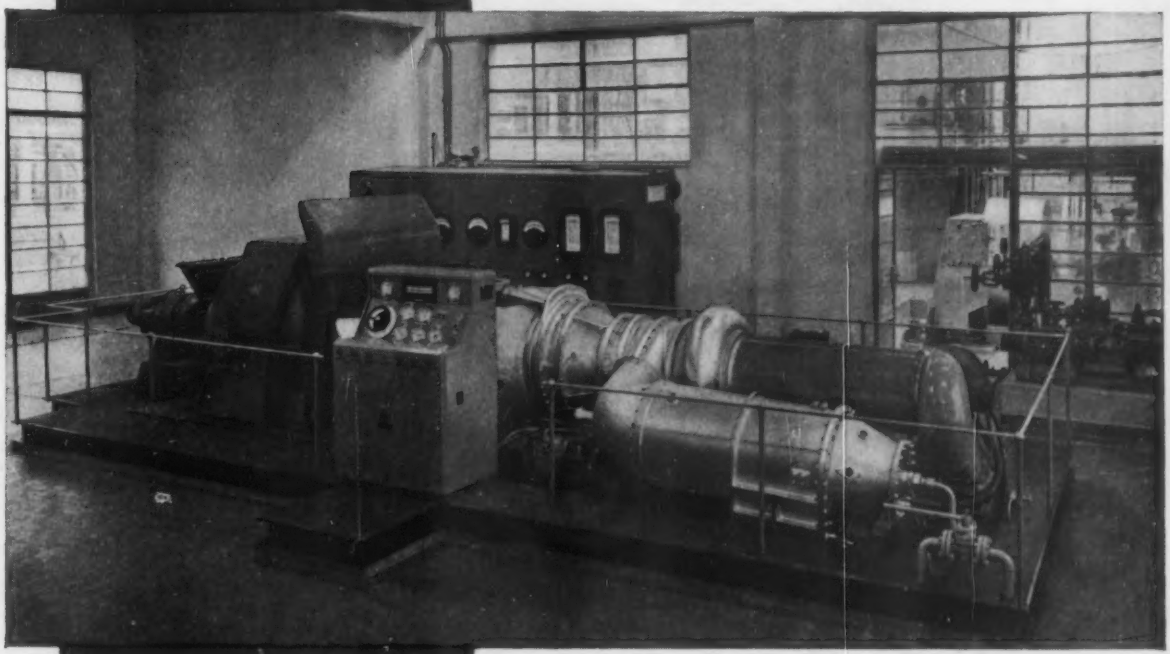
NOW for the first time...



The Mark TA gas turbine generating power and process steam in a refining application.

all power services in one package

In applications where multiple power services are required such as power generation, compressing, pumping, space heating, refrigeration, air conditioning, drying, or evaporating, the Clark Mark TA gas turbine is the economical choice.

Exhaust gases from this 1,150 bhp. gas turbine contain up to 10,000,000 BTU/H of recoverable energy at a temperature of 870°F. While these gases contain some products of combustion, 90% of the original oxygen content is still present.

The exhaust gases are useful where preheated air is desirable for combustion or supercharging purposes, for drying applications, catalyst regeneration, feedwater heating, evaporation of sea water, etc. These gases can also be used in air to air heat exchangers for space heating or to generate up to 9,500 pounds of low pressure steam per hour for process use. If even higher temperature gases are required, the Mark TA can be used solely as a power gas generator to provide gases of 1020°F at 20-22 psia. and a mass flow of 20 pounds per second.

For large stores, auditoriums, hotels, hospitals and office buildings, the Mark TA can provide approximately 1800 tons of air conditioning or refrigeration in the summer using the absorption cycle and also provide steam for heating in the winter. In all applications except power gas generating, this modern gas turbine also supplies 1,150 bhp. of rotative energy for pump, generator, or compressor drive.

Clark engineers stand ready to assist you in applying the Mark TA gas turbine to your application. Larger units with ratings of 9,500 bhp. are also available from Clark. Write for Bulletin No. 142.

CLARK BROS. CO., OLEAN, N.Y.
One of the Dresser Industries
Offices in Principal Cities Throughout the World

Clark Bros. Co. is licensed to manufacture the Mark TA gas turbine in this country by Ruston-Hornsby, Ltd., Lincoln, England.

CLARK

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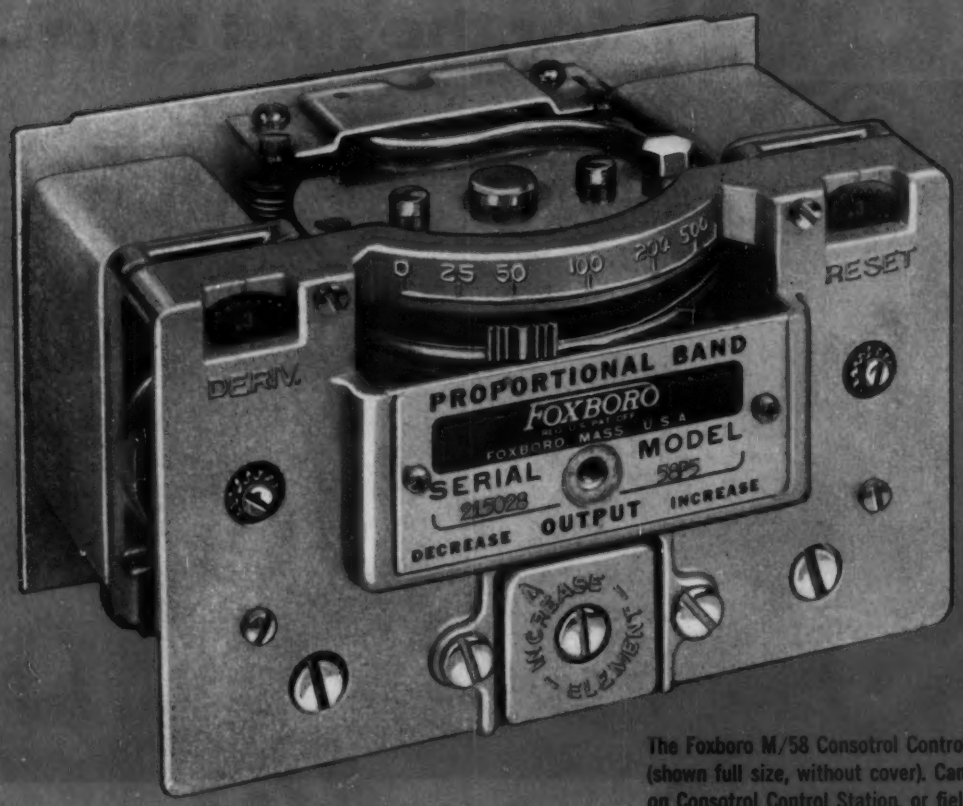


The Foxboro M/58 Consotrol Controller (shown full size, without cover). Can be panel-mounted on Consotrol Control Station, or field-mounted.

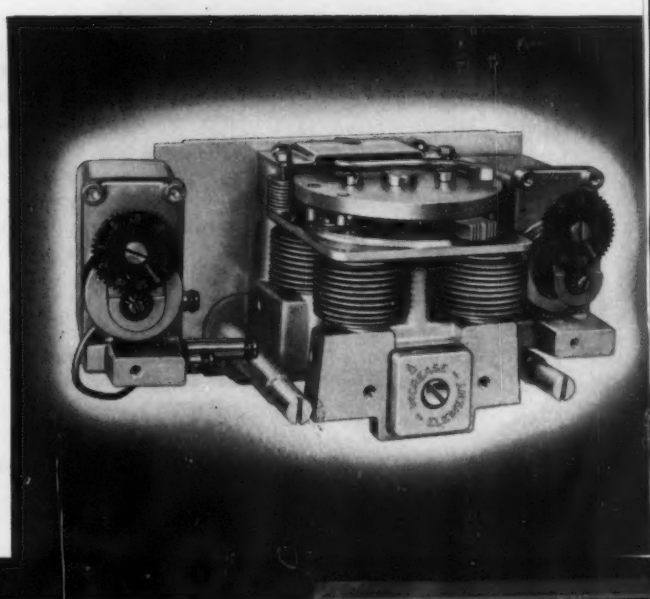
THE FOXBORO M/58 CONSOTROL

The M/58 Controller's Revolutionary Floating Disc System

Here's the exclusive Foxboro design development that gives M/58 Control its unique versatility, precision, and stability. The floating disc and matched bellows assure uniformly high controller sensitivity and pin-point control action, even at widest settings of the proportional band. Lever-set proportional band adjustment is calibrated to 500%.

Component Construction Gives Unrivaled Versatility

Not only is the complete controller easily detachable as a unit, but also, each component is a "plug-in" unit. For example, reset plugs in at right as shown; derivative, similarly, at left. All 4 control actions, with 2 reset ranges, are available and easily adjustable to widest variations in operating conditions. Proportional action from 1 to 500% quickly set by lever.



Outperforms all other controllers!

...the controller with the FLOATING DISC

If you think this claim is exaggerated, just put a Foxboro M/58 Consotrol* Controller on your process. The tougher the job, the more it will outperform other controllers! Or ask any present user . . . many of the largest, most progressive petroleum and chemical processors are using hundreds of these instruments. They will unhesitatingly confirm that this exclusive Foxboro development has put their processes "on stream", automatically and smoothly from the control room, without false starts or confusion.

The M/58 Controller can do the same for your process. The flexibility of its control functions makes it readily adaptable to *all* processing techinques. All four actions are available, with two ranges of reset . . . all are easily adjustable to the most widely varying operating conditions. For example, reset and derivative functions plug in . . . proportional action from 1 to 500% can be quickly set by a lever. And calibration is a simple zero adjustment!

Get full details on this simple, truly "universal" Controller. Write for Bulletin 13-19 and ask your Foxboro Field Engineer for a demonstration. **The Foxboro Company, 7411 Neponset Ave., Foxboro, Mass., U.S.A.**

*Reg. U.S. Pat. Off.

FOXBORO **CONSOTROL INSTRUMENTS**

Reg. U.S. Pat. Off.

KEY® RETURN BENDS–KEY-KAST FITTINGS in service at new Tidewater refinery

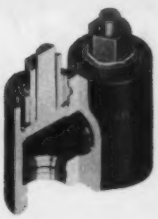
In Tidewater Oil Company's giant new Delaware Refinery, where "firsts" are commonplace, and "world's largest" describes many of the units, KEY products were chosen for their efficient, economical, long-lasting service.

The furnaces are equipped with KEY 5000 Type Return Bends. Their simple design, rugged construction mean dependable service. Only 26 parts for 18 different size fittings in two series mean substantial savings in inventory. In addition KEY 180° type "W" welding fittings were extensively used.

KEY-KAST alloy steel welding fittings in ells, tees and caps were furnished in schedules 40 and 80, sizes from 16" to 24", in low chrome moly steel.

KEY Return Bends and KEY-KAST fittings are bringing dependability and economy to refineries throughout the world. Specify KEY and KEY-KAST products for your next job.

KEY PRODUCTS SPECIFIED FOR TIDEWATER REFINERY



KEY 5000 Type Return Bend (PATENTED)

KEY-KAST 90° Elbows

KEY-KAST Tee

KEY-KAST 180° Return Bends.

5701

KEY Products on this project were supplied to

C. F. Braun & Co. • The Lummus Company
Foster Wheeler Corporation • Flori Pipe Co.

W-K-M
DIVISION OF ACF INDUSTRIES INCORPORATED

PLANT: MISSOURI CITY, TEXAS
MAILING ADDRESS: P. O. BOX 2117, HOUSTON, TEXAS

MANUFACTURERS OF W-K-M GATE VALVES · ACF LUBRICATED PLUG VALVES · KEY-KAST ALLOY STEEL PIPING FITTINGS · KEY RETURN BENDS AND FITTINGS

announcing new UOP #5-S* INHIBITOR

5 ways better!

1 MOST POTENT of all gasoline antioxidants. Absolute protection from gum formation and TEL decomposition in stored gasolines.

2 MOST VERSATILE inhibitor-sweetener. Handles even gasolines formerly considered "impossible."

3 MOST RAPID sweetening action. *One-fourth to three-fourths faster* oxidation of malodorous mercaptans means a more flexible operation, less storage equipment needed.

4 MOST PROTECTION against engine deposits because phenylene diamine type eliminates their primary cause, gum formation.

5 MOST ECONOMICAL. *Five* molecules of UOP #5-S protect and sweeten a *million* molecules of gasoline . . . a cost of less than ½¢ per bbl.

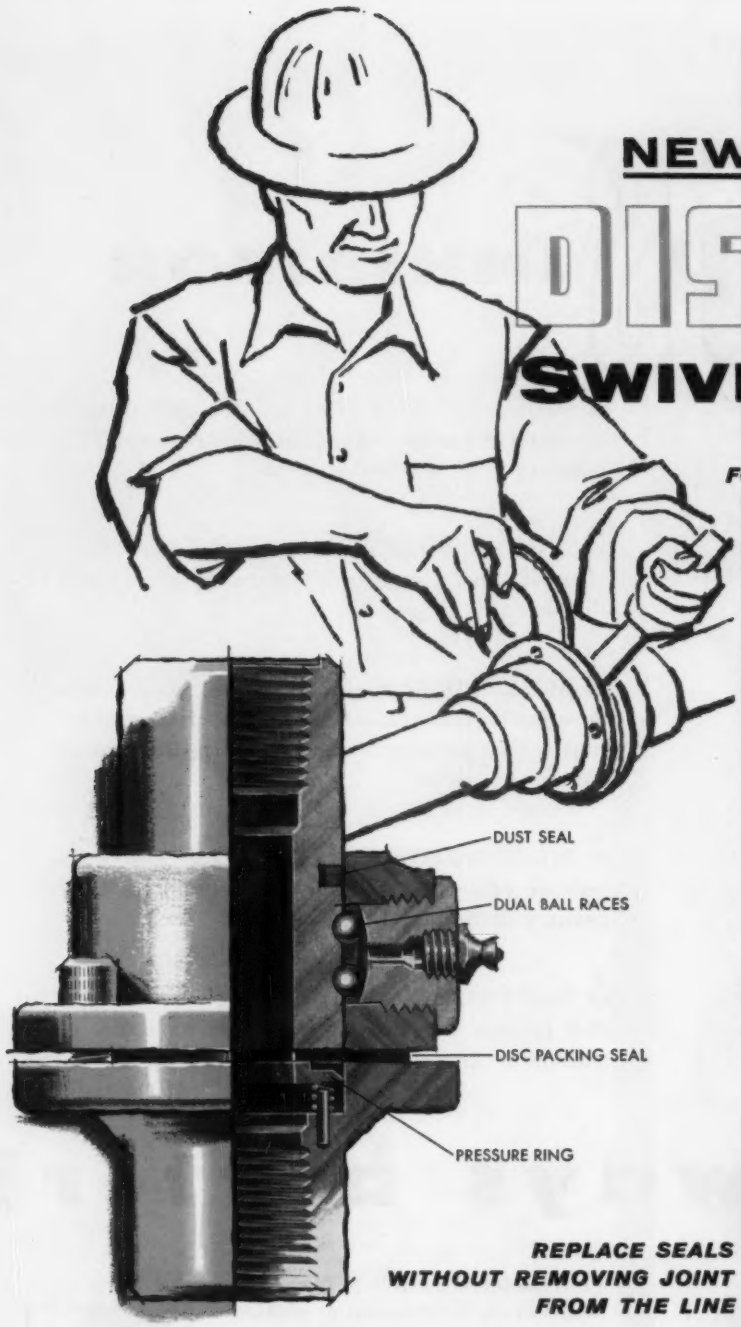
Universal Oil Products Company has pioneered in the development of products and methods for better, more economical gasoline finishing. If you have a stability or quality problem, drop us a line and we'll be glad to help you to a solution.

*Trademark

UOP® UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U. S. A.

For more data on advertised products, use Readers' Service Cards, last page.

NEW CHIKSAN DISCPAK SWIVEL JOINTS

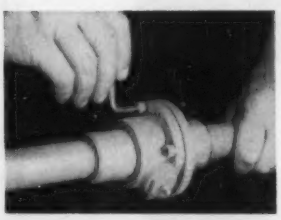


FOR STEAM AND HOT GAS SERVICE

Created specifically for service on lines employed in steam and hot gas service, the Chiksan Discpak embodies a new construction design which permits packing units to be replaced without removing the joint from the line. The outer housing of the Discpak is cut apart at the packing chamber and both ends are flanged at the cut. Four allen-type cap screw bolts are used to secure the flanges. A disc-seal, housed between the two members, provides a fluid-tight seal between rotating and stationary members of the Discpak Swivel Joint. A spring loaded pressure plate holds the packing in sealing position against the swiveling member.

The new Discpak has a maximum temperature rating of 600° F. and a maximum pressure rating of 300 psi. All turning movement in the Discpak takes place on a double row of precision ball bearings. Write today for literature and prices. If your plant or equipment lines utilize hot gas or steam, it will pay you to know about this new field-proven Discpak swivel joint.

REPLACE SEALS WITHOUT REMOVING JOINT FROM THE LINE



To replace the disc-seal, simply remove four allen screws and spread line slightly with a flat metal bar.

CHIKSAN

CHIKSAN COMPANY, 330 No. Pomona Avenue, Brea, California
A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

fmc

Please rush me a copy of your new Discpak Bulletin

NAME_____

COMPANY_____ TITLE_____

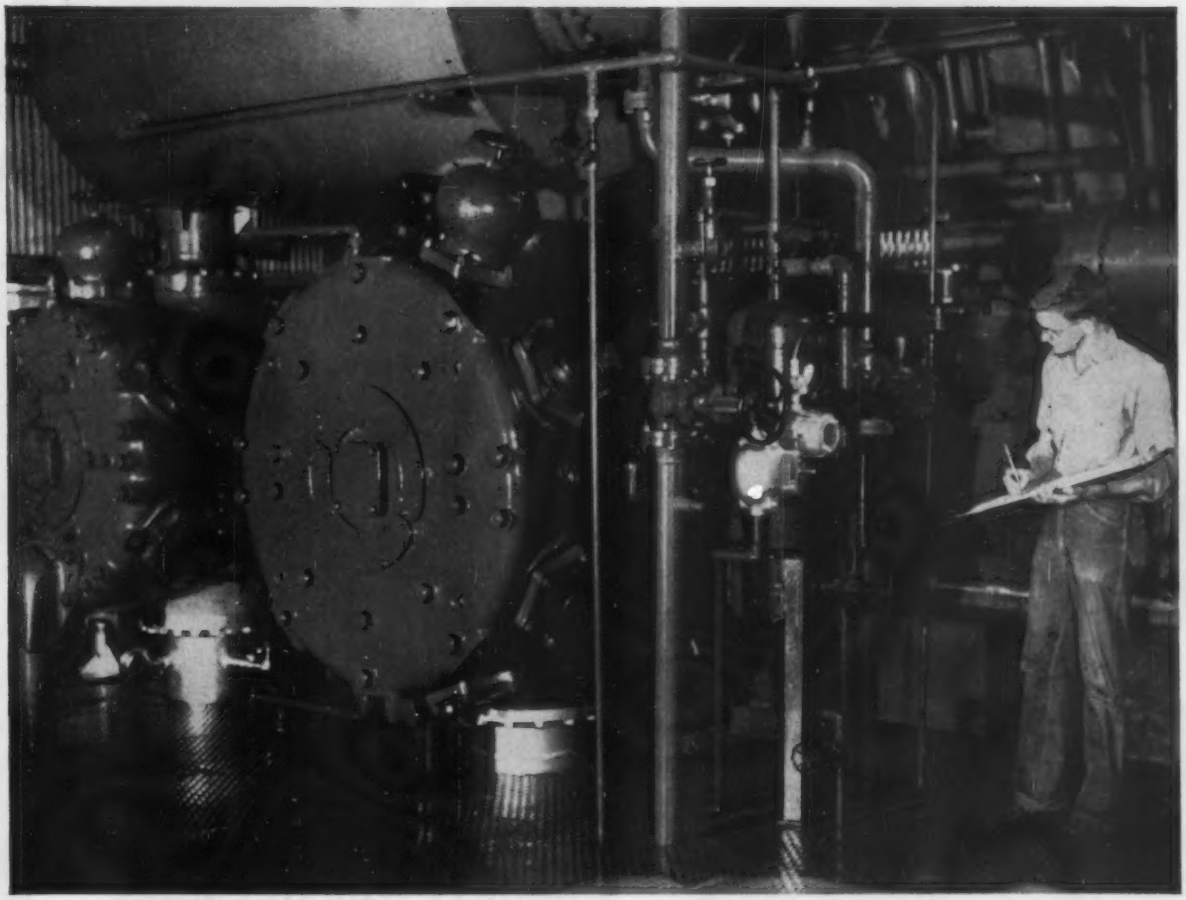
CITY_____ ZONE____ STATE_____

Dept. 511

SEND FOR BULLETIN

New Discpak Bulletin 100 describes in detail the many features of this new swivel joint including full mechanical specifications.

57-26



Ease your mind about air compressor fires... with fire-resistant PYDRAUL® AC lubricant

Forget the anxiety of possible fires and explosions in your air compressors!

Successful field experience throughout industry proves that fire-resistant Pydraul AC protects against these hazards, gives excellent lubricity and can minimize carbon deposits on air compressor exhaust valves and air piping systems... where your fire danger really lurks.

From the largest reciprocating air compressor to the smallest portable... fire is a persistent worry, unless you use fire-resistant Pydraul AC to protect your investment.

Conversion is easy... essentially, just drain your flammable oil and replace with fire-resistant Pydraul AC.

Write today for Monsanto's new bulletin covering details on use of Pydraul AC.

There's also a Pydraul for every industrial job:

- General-purpose Pydraul F-9.
- Pydraul 150 and Pydraul 60 for precision equipment.
- Pydraul 600 for heavy equipment.

Pydraul: Reg. U. S. Pat. Off.

MONSANTO CHEMICAL COMPANY
Organic Chemicals Division, Dept. PAC-79, 800 N. 12th Blvd., St. Louis 1, Missouri
In Canada: Monsanto Canada Ltd., Montreal

MONSANTO®

WHERE CREATIVE CHEMISTRY WORKS WONDERS FOR YOU

For more data on advertised products, use Readers' Service Cards, last page.

Stainless transfer lines last three times as long as carbon steel —*still no sign of corrosion*

The picture shows the Pure Oil Company Smith's Bluff Refinery at Nederland, Texas. The two-stage distillation unit contains both atmospheric and vacuum furnaces, and both of them used to have carbon steel transfer lines. They lasted an average of 1½ years.

About four years ago, they replaced the lines with Type 304 Stainless Steel lines, in an effort to lick high temperature sulfur and chloride corrosion. The project was a complete success because, after four years, there is still *no* sign of corrosion.

In high-production, modern refineries like this one, there are very few investments that will pay off as well as Stainless Steel. Naturally, you get your greatest return when you design with Stainless from the very beginning. And you get the assurance of service-tested quality when you design with *USS* Stainless Steel.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS • STRIP • PLATES • BARS • BILLETS • PIPE • TUBES • WIRE • SPECIAL SECTIONS

UNITED STATES STEEL

FLUID CONTINUUM a study in stainless steel by Robert Engman—Yale University for Fluid Systems, Incorporated

THERMAL ELECTRIC

A SYSTEM*

- - - - that guarantees even, dependable heat throughout your entire viscous-fluid piping and storage system

Designed by

FLUID SYSTEMS, INC.

- - - - specialists in solving your viscous-fluid handling problems.

Thermal Electric Systems are designed for:

- Pipe runs from 100 ft. to over 100,000 ft.
- Pipe sizes from ½" to 24" in carbon steel, wrought iron, and stainless steel.
- Temperatures from just above 32°F to 600°F.
- A wide range of fluids including Asphalt and HiVis Resids, Sulfur, Paraffin and Petro-Chemicals, and also food products, such as chocolate, syrup and molasses.

The operating cost of a pipeline heated by Thermal Electric is invariably lower than any other method, and most important — Thermal Electric means UNINTERRUPTED PERFORMANCE.

* *Thermal Electric® heating is accomplished by impressing carefully controlled increments of low voltage 60 cycle current to the same pipe in which your product is contained. For Heated Storage, the same principle is utilized to warm pipe coils in the tanks.*

For additional *Thermal Electric* information. Write today

Trademarks Reg. U.S. Pat. Off.

FLUID SYSTEMS INC.

1881 DIXWELL AVENUE • NEW HAVEN 14 • CONNECTICUT

NEW YORK • NEW HAVEN • CHICAGO

Fluid Systems INC.

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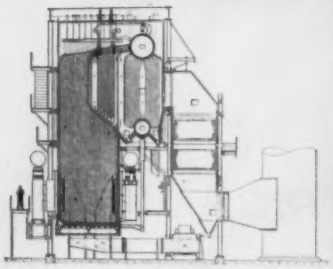
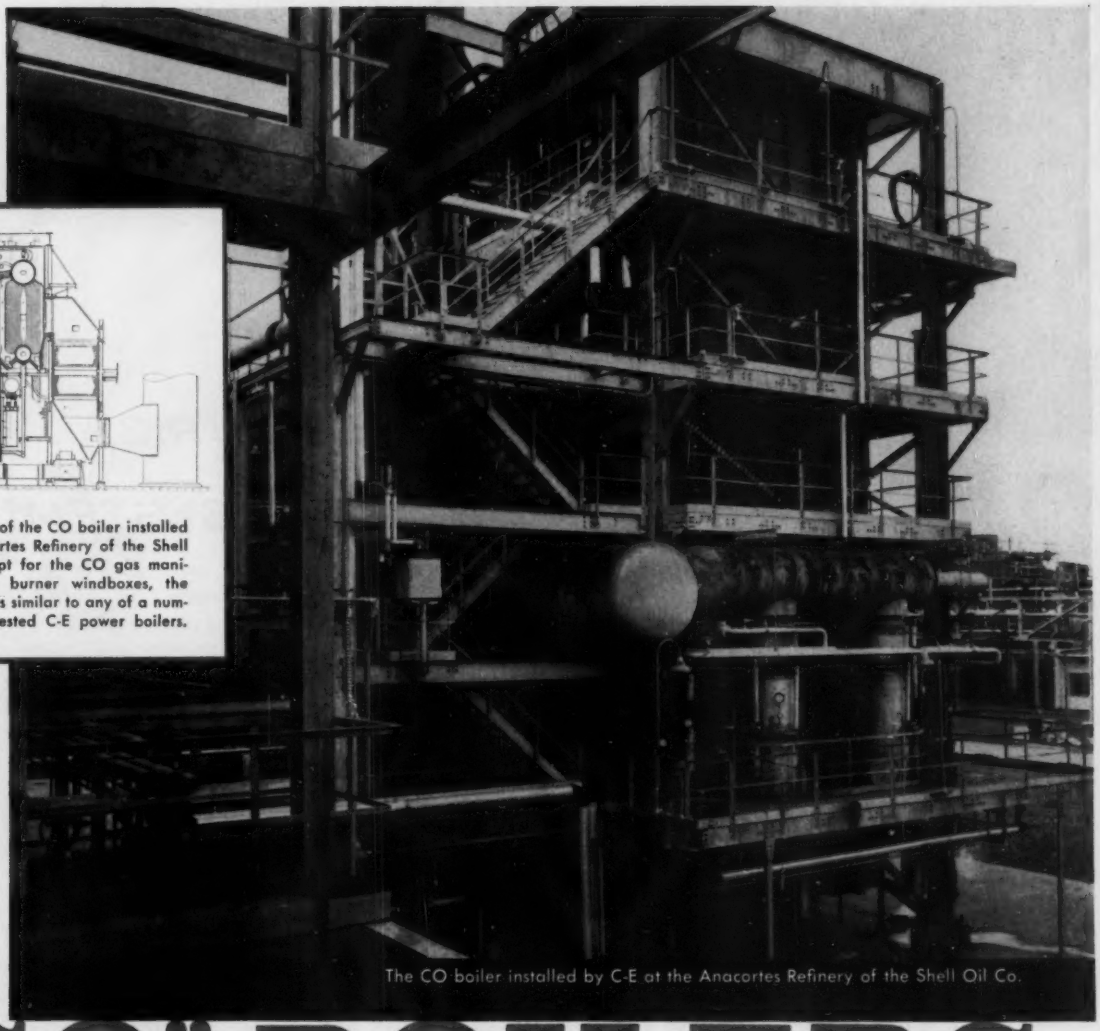


Cross section of the CO boiler installed at the Anacortes Refinery of the Shell Oil Co. Except for the CO gas manifolds to the burner windboxes, the cross section is similar to any of a number of time-tested C-E power boilers.



The CO boiler installed by C-E at the Anacortes Refinery of the Shell Oil Co.

"CO" BOILERS

Advanced in Design · Tangentially Fired

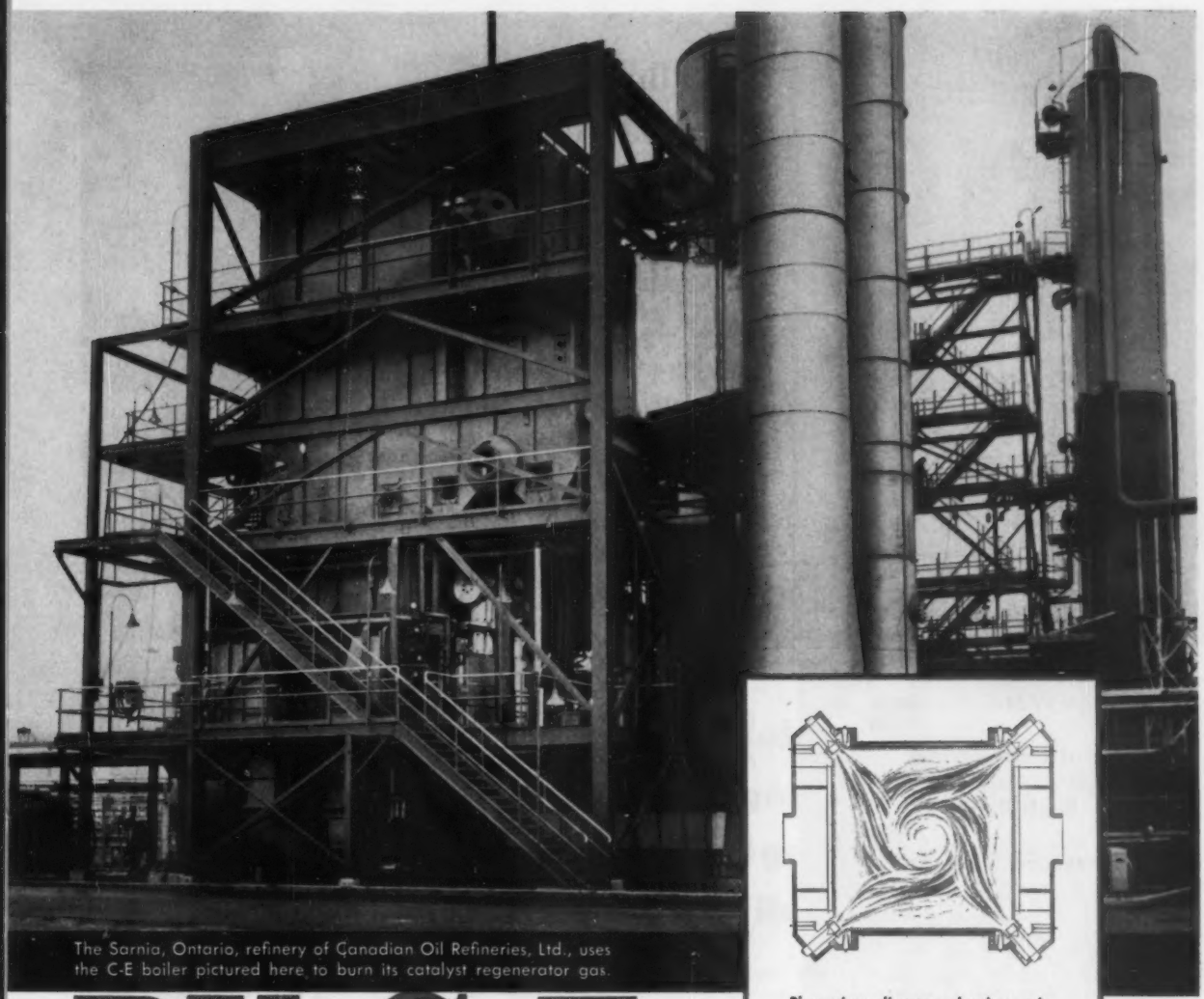
All CO boilers by C-E are of advanced design, yet conventional in appearance. They require no specialized and complicated device to burn the lean, moist and toxic gas from a catalyst regenerator. Rather, they use the time-tested principle of tangential firing—a principle ideally suited for use with lean fuels. Located in each of the four corners of a conventional furnace, each burner directs layered streams of CO gas, supplemental fuel and air to a small imaginary circle lying in a horizontal plane in the center of the furnace. These streams impinge on each other, and the

COMBUSTION

Combustion Engineering Building

CANADA: COMBUSTION ENGINEERING-

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;



The Sarnia, Ontario, refinery of Canadian Oil Refineries, Ltd., uses the C-E boiler pictured here to burn its catalyst regenerator gas.

Plan view diagram showing principle of tangential firing in a completely water-cooled furnace. Air ducts, dampers and ignition torches are indicated.

BY C-E

Double Steel Cased · Service Proved

lean gas begins to burn immediately upon entering the furnace. Because of the intense turbulence and the length of the horizontal flame travel, combustion is completed within a short vertical distance in the furnace.

In terms of general experience, a total of more than 675 tangentially fired C-E boilers have been purchased to date. As to specific experience with lean fuels, C-E—in addition to its CO boiler installations in refineries—has installed more than 150 boilers burning blast furnace gas . . . a fuel similar to CO gas with a heating value of about 80 btu per cubic foot.

ENGINEERING

200 Madison Avenue, New York 16, N. Y.

SUPERHEATER LTD.

C-128

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

Fabricators of:

PRODUCTS

Absorbers

Bubble Towers

Bubble Caps

Bubble Trays

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Evaporators

Fractionating Columns

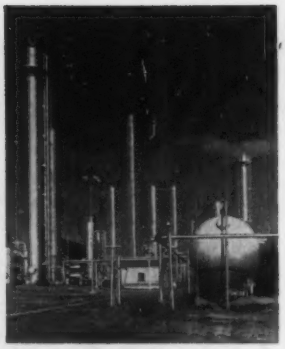
Jacket Water Coolers

Heat Exchangers

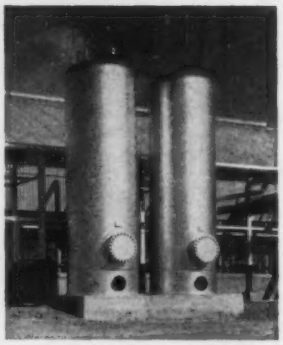
Stabilizers

Pressure Vessels

GASOLINE PLANT, OIL REFINERY and CHEMICAL PROCESSING EQUIPMENT



For over forty years FLINT has been one of the largest and best equipped fabricators of Process Equipment for the Petroleum & Chemical Industries.

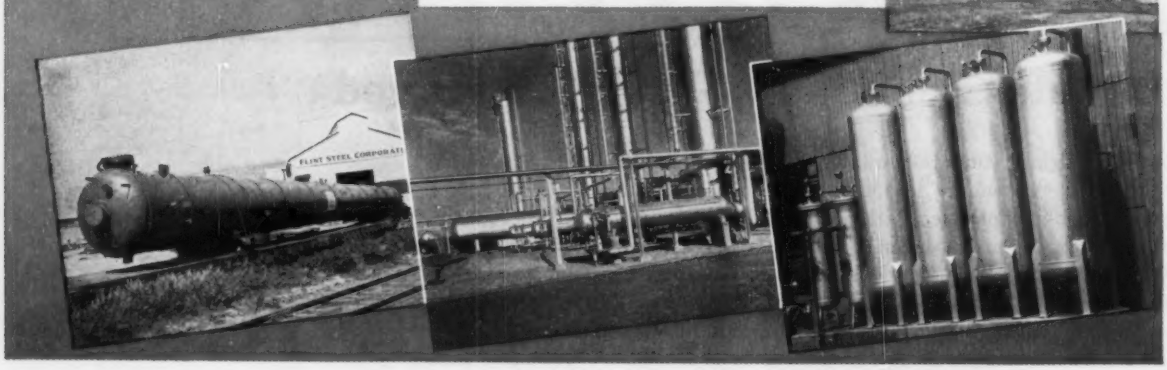


Roll capacity is 1¾″ or 2″ thick plate. Flint also has Radiograph and stress relieving equipment.

API-ASME or the ASME CODE for Unfired Pressure Vessels is complied with readily.

Stress relieving furnace is 15′ 2″ wide by 85′ long.

The manufacturing facilities of the two Plate Shops with their machinery and equipment make Flint one of the largest fabricators of steel plate products for the Processing Industries in the country.

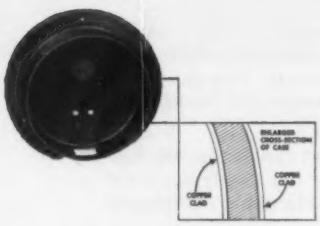


STEEL PLATE FABRICATORS ASSOCIATION

FLINT STEEL CORPORATION

TULSA ..... MEMPHIS

You're looking at the biggest pressure gauge development since the "Recalibrator"



Another first for Marsh

Here is a case in keeping with the "Conoweld" tube. Another recent Marsh development, it is called the

New *Marshalloy* Case

It is a copper-clad wrought steel case of boiler plate thickness, four times as strong, and one-third lighter than conventional cast iron cases. Copper surface makes it as non-corrosive as a plastic or die-cast case. Handsome, corrosion-resistant, satin black enamel and Marsh safety blow-out plug are the finishing touches.

Here is one of those typically MARSH developments . . . the kind of pioneering step you have come to expect from the organization that originated the basic advances in pressure gauges culminating in the exclusive "Recalibrator." This latest Marsh development is known as the

NEW MARSH *"Conoweld"* TUBE

This time we have made the best part of the best Marsh gauge still better. We have gone into the part that actually does the work — the socket and tube — and have made it permanently leak-tight from inlet to tip of tube.

We have done this by fusing the tube into the socket and the tip to the tube so that the whole assembly is truly *one piece*. The photo of one of the sockets sawed in half shows the perfect fusion of the vital joint. Tests and photomicrographs prove the perfection of the fusion.

Developing the fusing process called for extensive research. The method as finally perfected — the "Conoweld" process — involves first fusing the tube to the socket and end-piece; then tempering the tube to required resiliency.

Yes, it is these dramatic departures from beaten paths that have achieved leadership for Marsh gauges and are ever increasing that leadership. Ask for latest information covering gauges for all services.

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corporation* Dept. R, Skokie, Ill.

Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta

Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

MARSH GAUGES

"THE STANDARD OF ACCURACY"

MANUFACTURERS OF THERMOMETERS • WATER REGULATING VALVES • SOLENOID VALVES • HEATING SPECIALTIES

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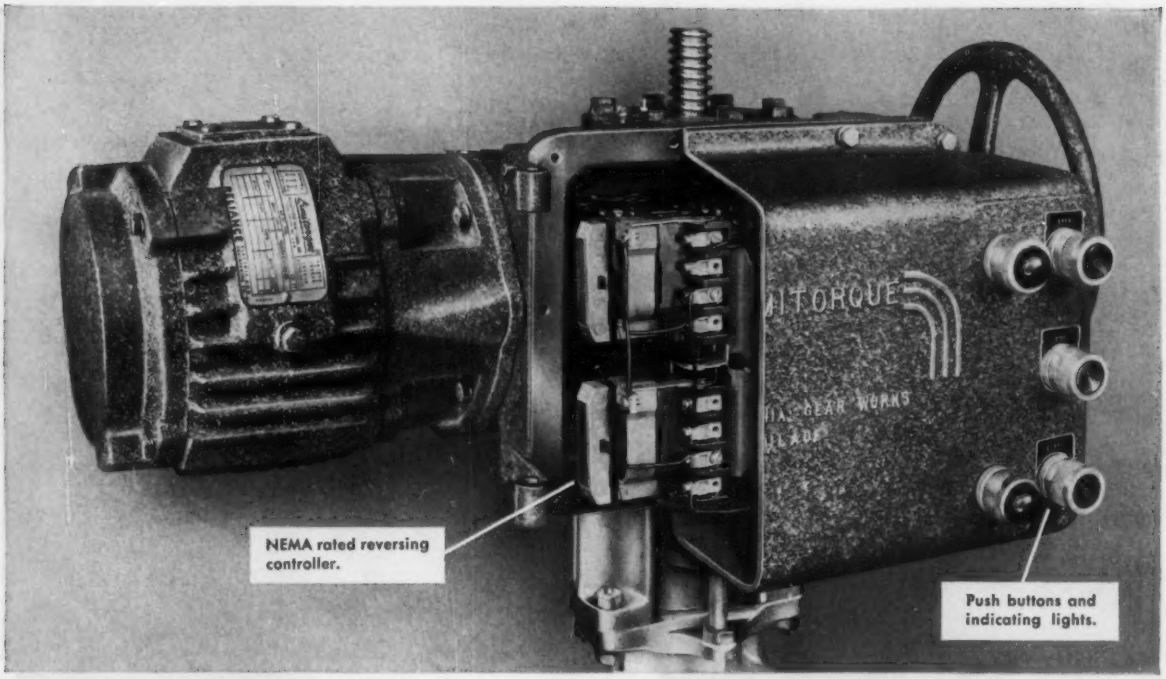


Reduce Installation, Equipment Costs 50%

LimiTorque Value Operators feature fully integral controls for quicker, easier installation, operation

LimiTorque is first again! LimiTorque valve operators now feature integral NEMA rated reversing controllers, push button and indicating light elements. You can actually reduce the installation and component equipment costs up to 50%.

Various combinations of control items can be included in the same switch compartment. Why use costly separate control components when they are obtainable completely wired in your LimiTorque.

To compensate for temperature ranges, overloads are adjustable from 85% to 115% of the heater rating, thereby eliminating stocking of replacement heaters.

Push button elements, selector switches, etc., when required, are mounted in the hinged cover for quick, easy accessibility to all control components. LimiTorque can be field mounted on your existing valves. Contact your valve manufacturer or closest LimiTorque sales engineering office.

Remember, today's trend is toward low cost simplicity. LimiTorque operators with integral controls are designed with this in mind. Write today for Bulletin 6-57.

Minimize use of these costly components!

- Separate push button and control stations
- Separate reversing controllers
- Control racks
- Conduit runs, condulets
- Enclosures, wiring
- Labor required for above items

LimiTorque®

PHILADELPHIA GEAR WORKS, INC.
ERIE AVE. & G STREET. PHILADELPHIA 34. PENNA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

After 18 years in service making SPRY...

Bridgeport Duplex Tubes still deliver top performance

Two of seven heat exchangers in which Bridgeport Duplex Tubes have established an unusual 18-year performance record at Lever Brothers.

In 1939, seven heat exchangers with 150 Bridgeport Duplex Condenser Tubes in each unit were installed in the Hammond, Ind. plant of Lever Brothers for use in producing Spry all-vegetable shortening.

Today, after 18 years of service, almost all of these Bridgeport Duplex Tubes are still in use—and giving dependable performance.

Used as oil coolers, each heat exchanger has a horizontal bank of 5/8" OD Bridgeport Steel/Copper Duplex Tubes. Before Bridgeport Duplex Tubes were installed, low-carbon steel tubes were used with disappointing results. Maximum service life of the steel tubes was two years, with some failures occurring after two months' service. *With Bridgeport Duplex Tubes installed, average in-service life was ten years.*

This outstanding performance is possible because with Duplex Tubes the best properties of two different metals are utilized to greatest advantage.

This case emphasizes how Bridgeport Duplex Tubes provide a dependable, economical answer to dual corrosion problems. For full information on Duplex and standard condenser tubes, call your nearest Bridgeport Sales Office today.

Send for "Bridgeport Metal Laminates." Interesting facts on Bridgeport metal laminates, including information on bi-metal tube sheets and Duplex Tubes, are contained in this 8-page book. Write for your free copy today.

BRASS Bridgeport CO.

BRIDGEPORT CONDENSER TUBES

Bridgeport Brass Company, Bridgeport 2, Conn. • Sales Offices in Principal Cities

In Canada: Noranda Copper and Brass Limited, Montreal.

For more data on advertised products, use Readers' Service Cards, last page.

because of GLYCOLS *and* ETHANOLAMINES

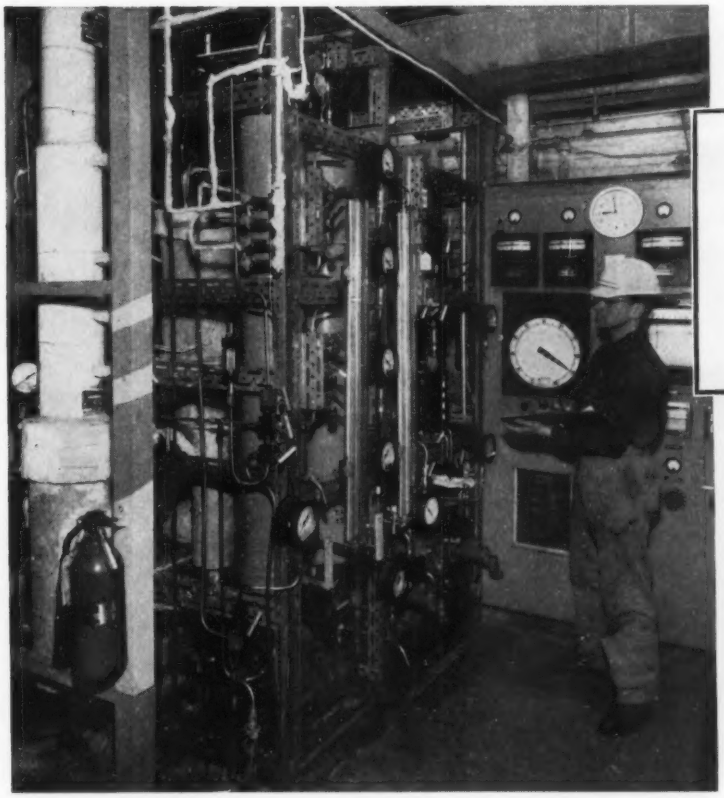
Wet or sour gases, once flared as a nuisance, now produce millions in revenue — thanks to the glycols and ethanolamines. If you use these versatile chemicals for gas dehydration or purification, you want to be sure of steady supply and instant service. Allied glycols and ethanolamines are available in tank car lots from Nitrogen Division's Orange, Texas plant, and in tank trucks or drums from warehouses in principal producing areas. Allied's technical specialists are always on call to help with any application problems you may have.

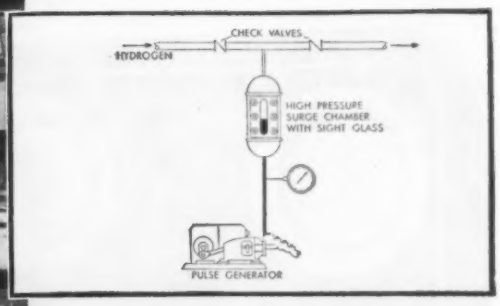
Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Solutions • Nitrogen Tetroxide • Fertilizers & Feed Supplements

Dept. GA 1-21-5

Allied Chemical — Nitrogen Division

40 Rector Street, New York 6, N. Y.





Piping system for hydrogen gas, where a Milton Roy pulse generator strokes a liquid piston which, in turn, circulates hydrogen through the check valves.

In a typical multi-purpose pilot plant, a Milton Roy duplex type pulse generator, acting on a liquid column, circulates hydrogen gas at pressures to 750 psi.

Controlled Volume Pumps assure accurate gas metering in reforming and hydrogenation pilot plants

Development engineers with multi-purpose pilot plants for reforming and hydrogenation are using Milton Roy Controlled Volume Pumps—pulse generators—to assure accurate metering of material flows. These generators stroke liquid pistons which pump and meter the gas . . . at the same time, act as seals and prevent costly leakage.

Available in simplex or duplex designs, Milton Roy pulse generators will operate liquid pistons at pressures up to 50,000 psi. The largest model—with a 3½" diameter plunger—displaces a maximum of 57.5 cubic inches per stroke.

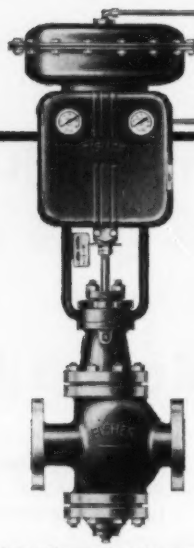
It will pay you to investigate this approach. Wherever you use Milton Roy Controlled Volume Pumps, you'll find reduced chemical costs . . . upgraded product quality . . . savings in operating and maintenance expense. Milton Roy Company, *Manufacturing Engineers*, 1300 East Mermaid Lane, Philadelphia 18, Pa.

Write for application data on Controlled Volume Pumps as used in Pilot Plant Gas Recycling Systems (Data Sheet E-57-2).

milton Roy
CHEMICAL FEED SYSTEMS

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America, Africa and Australia

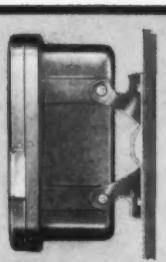
For more data on advertised products, use Readers' Service Cards, last page.



Any of the Wizard controllers can be yoke mounted on a diaphragm control valve to make a compact pilot operated pressure regulator as shown above. All Wizards are normally supplied with an operating medium air set which filters and reduces supply pressure of 25 to 250 psi to constant pressure of 20 psi for 3 to 15 psi, or 35 psi for 6 to 30 psi operation.

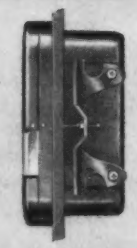
SURFACE MOUNTING

The Wizard can be mounted on the surface of a wall or any stable surface. A special mounting bracket is provided and any type of screw or bolt suitable for the mounting surface may be used.



FLUSH MOUNTING

By turning the bracket around that is provided for surface mounting, any Wizard can be mounted flush to a panel.



WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

For closer control in today's

more complex processing industries

FISHER®

WIZARD II

PRESSURE CONTROLLER

For over a quarter century, the name "Wizard" has become a byword as the pressure controller that is accurate, dependable and simple to operate in all types of industry.

Now, the WIZARD II takes over to meet the demands of modern, complex control systems requiring closer control. The WIZARD II retains all of the basic simplicity, accuracy and dependability of the Wizard 4100U, plus a number of new components. The WIZARD II is in a waterproof aluminum die-cast case and cover with ¼" tapped vent for gas service. With the addition of a few parts, the basic proportional controller can be converted to: (1) two-position action or "Snap Action", (2) pressure transmitter, (3) controller with remote set adjustment, (4) proportional plus reset response. The WIZARD II can be changed from direct to reverse action or vice versa without additional parts.

The superior subassembly construction stresses simplicity and compactness. Each subassembly is assembled and calibrated prior to mounting in the case. All Series 4150 Wizards can be supplied for remote set adjustment for changing the pressure setting from a location away from the Wizard controller.

Careful and exhaustive tests have conclusively proved that the WIZARD II measures up to the rigid Fisher standards.

A completely descriptive and illustrated bulletin on the WIZARD II is yours for the asking. Write today for Bulletin No. D-4150.

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Marshalltown, Iowa / Woodstock, Ontario

FISHER® Controls

SINCE 1880

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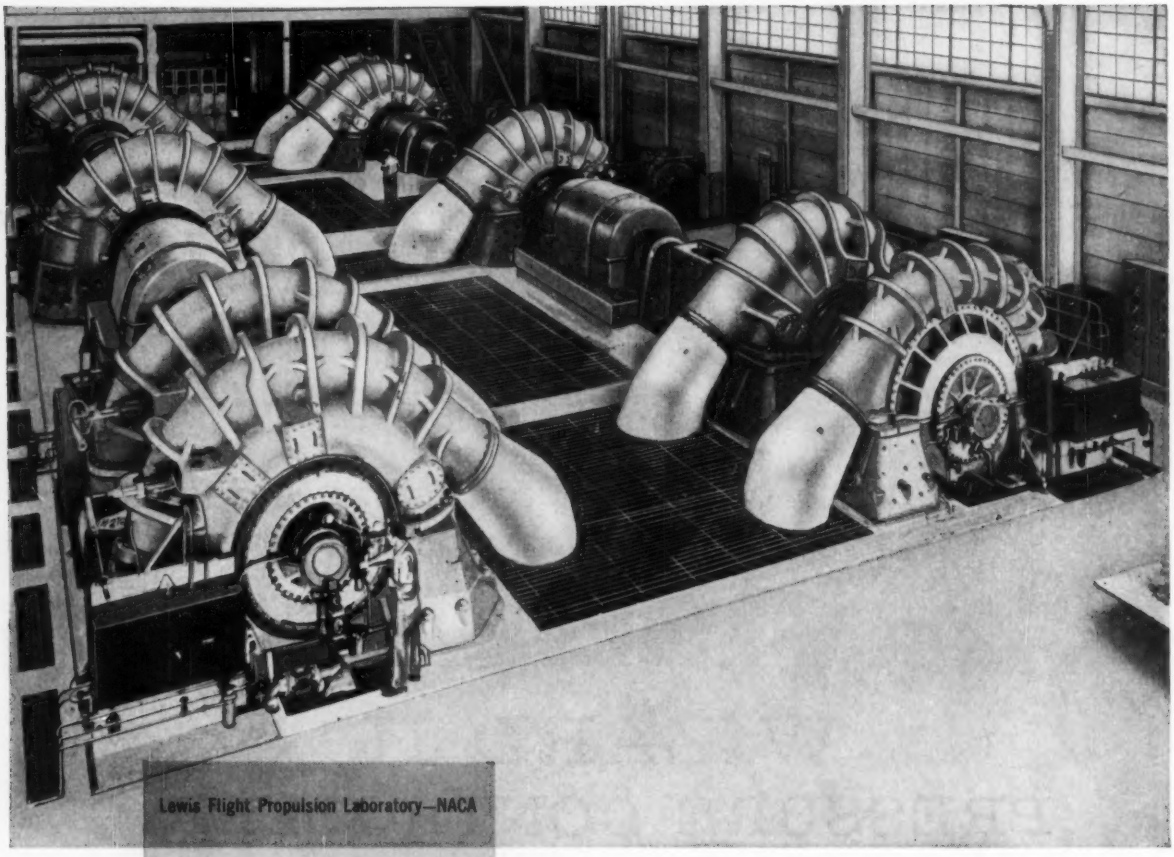

Lewis Flight Propulsion Laboratory—NACA

How one of the world's largest wind tunnels can help a refinery man!

Roots-Connersville supplies a complete line of air and gas handling equipment . . . centrifugal, Spiraxial® and rotary positive blowers, exhausters and compressors . . . rotary positive gas pumps and meters . . . rotary vacuum pumps . . . for manufacturing and process industries.

From violent, roaring cyclones of air to silent, almost perfect vacuums . . .

atmospheres "in the mass" are created and precisely controlled to order by these giant Roots-Connersville centrifugal blowers at Lewis Flight Propulsion Laboratory in Cleveland, Ohio.

In solving unusual air and gas handling problems such as this, Roots-Connersville draws on a highly developed engineering and manufacturing skill. For over 100 years, R-C equipment has been meeting the most exacting requirements of industry around the world.

Roots-Connersville, one of the Dresser Industries, will be glad to put its broad knowledge and experience to work for you. Your problem will receive immediate attention from our Application Engineering Department.

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A DIVISION OF DRESSER INDUSTRIES, INC.

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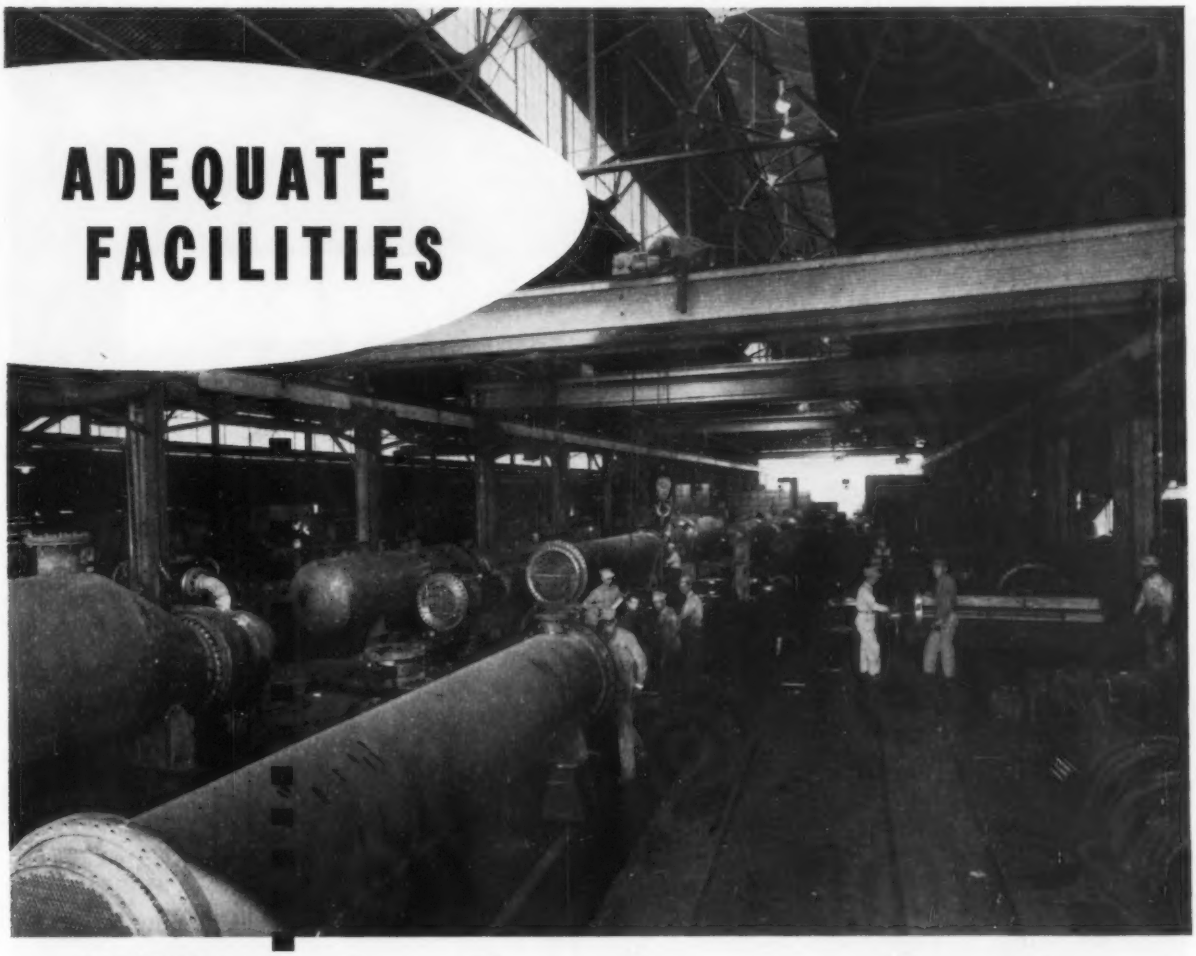
—unusual career opportunities await you at Roots-Connersville. Address your resume to Professional Employment Manager.



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- **guaranteed job ratings**
- **complete fabricating facilities**
- **technical service before, during and after installation**

One reason that Efco does it *right* is its many years of experience in designing and fabricating heat-exchangers for the wide range of temperatures and pressures represented by ethylene plants and platinum catalyst reforming units. We are recognized specialists in handling all grades of carbon, alloy, and stainless steels, nickel, aluminum, and special low-temperature materials.

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EFCO HEAT TRANSFER EQUIPMENT

Engineers and Fabricators, Inc.

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you can meet any lubrication specification if you

BLEND WITH ENJAY PARANOX®

(DETERGENT-INHIBITOR ADDITIVES)

Blended with Paranox, lubricants can be compounded to combine *both* minimum wear and maximum engine cleanliness characteristics. That's why more and more refiners and blenders are relying *exclusively* on Paranox in formulating lubricants for heavy duty equipment and all engines that are subjected to tough operating conditions.

Through years of intensive research and development work with manufacturers and oil companies, Enjay has developed the only *complete line* of high quality additives (Paramins®) that can assure *maximum* performance characteristics. Why not let this experience and know-how work for *you*? Contact the Enjay Company today.

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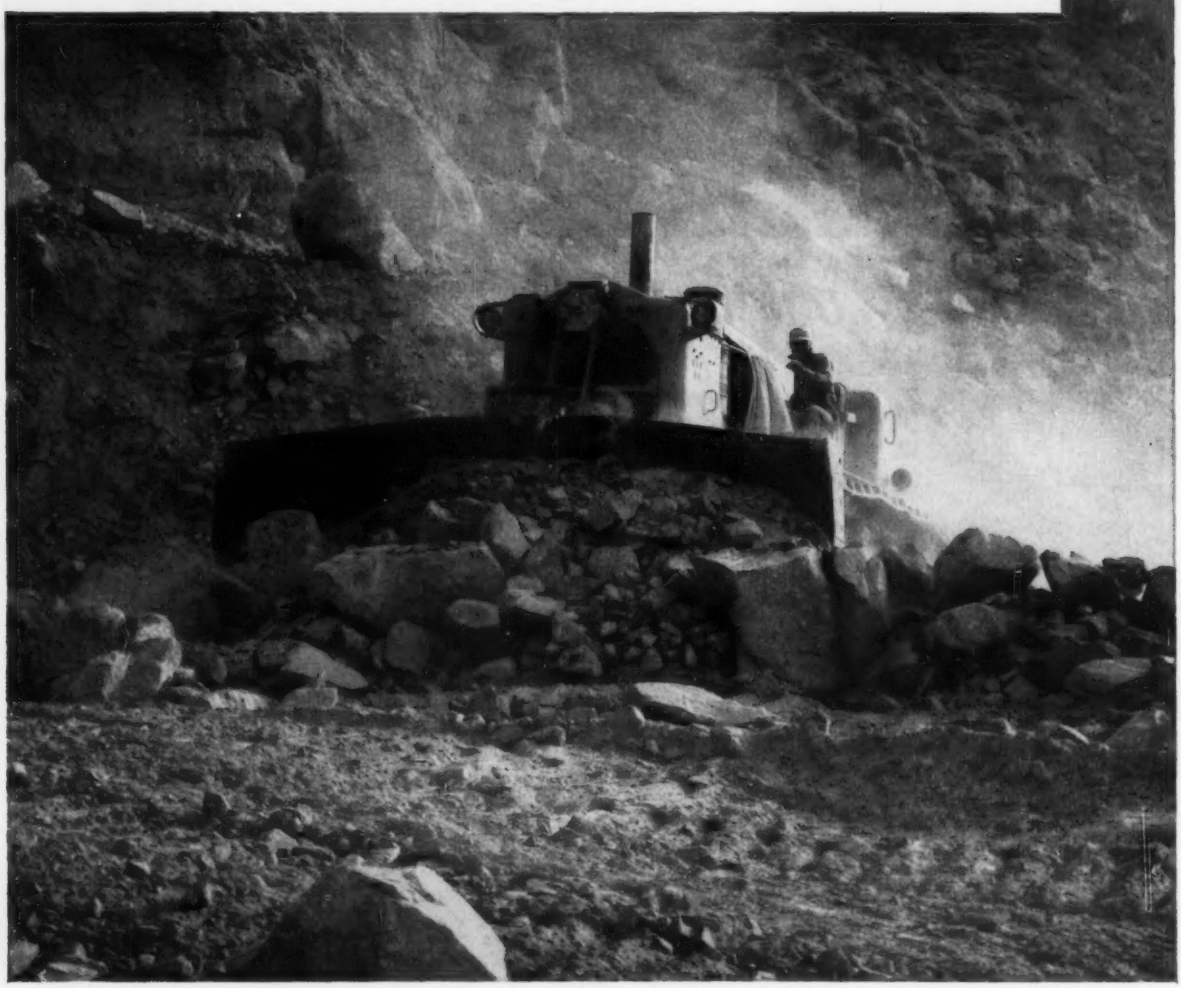
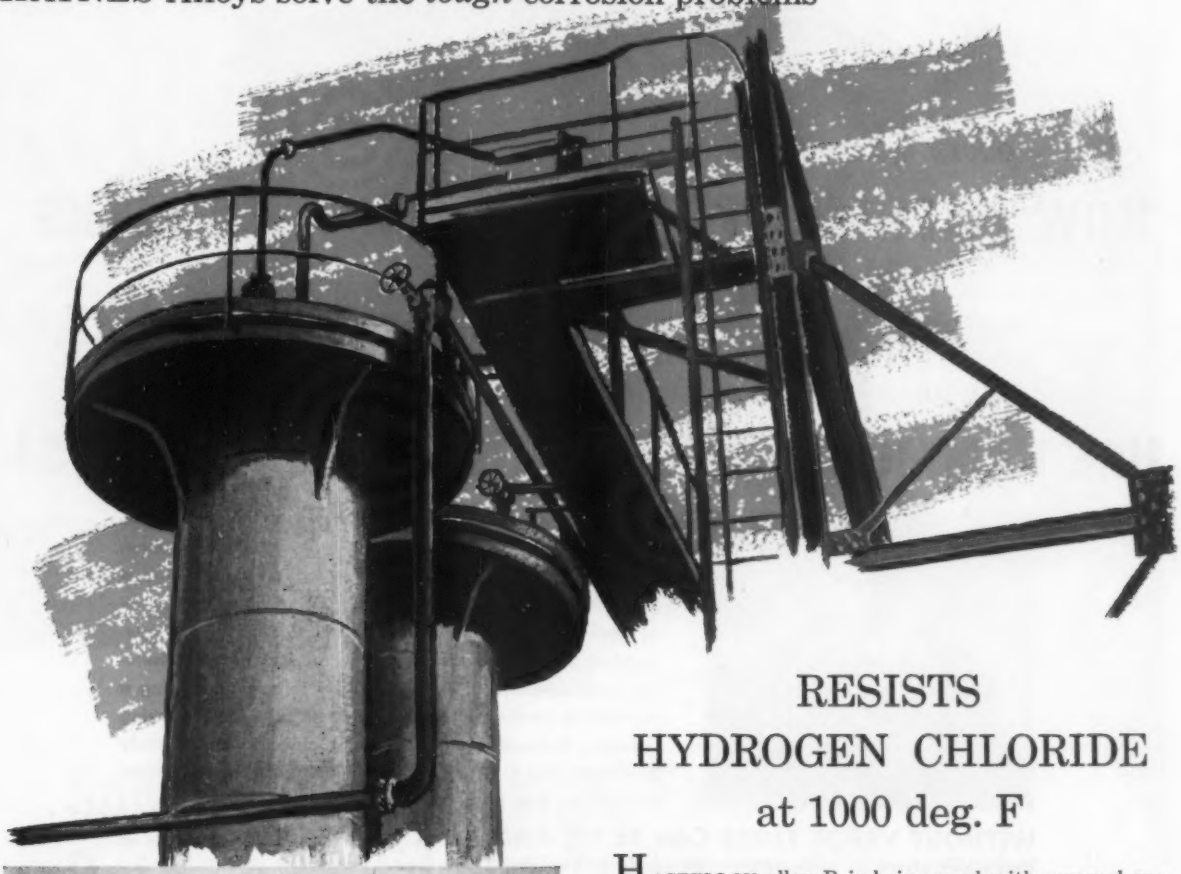


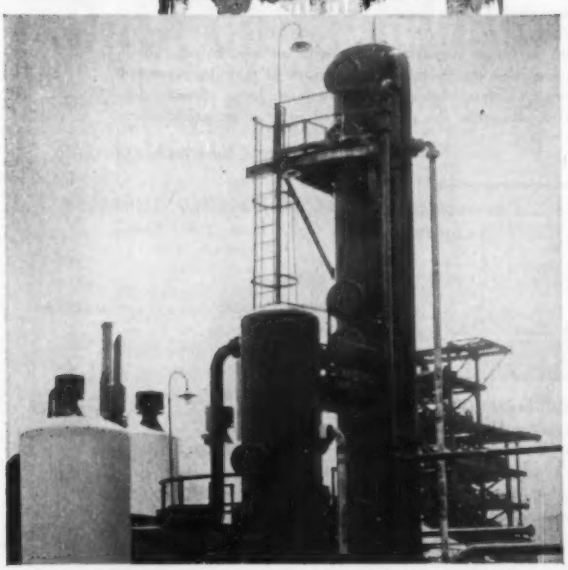
HAYNES Alloys solve the *tough* corrosion problems



RESISTS HYDROGEN CHLORIDE at 1000 deg. F

HASTELLOY alloy B is being used with unusual success in equipment exposed to hot hydrogen chloride gas containing water. In one installation, where the highly reactive gas is at 1000 deg. F., alloy B has outlasted previously used materials by 30 to 40 times! Here, tower covers, piping, and valves made of alloy B are located on top of chlorine burners in a tetraethyl lead plant. They were in service for 6 years before requiring maintenance.

Hydrogen chloride gas is only one of thousands of corrosives that are successfully handled by HASTELLOY alloys. These nickel-base materials have unusual resistance to the hot mineral acids, strongly oxidizing salts, and powerful gaseous oxidants. For complete information, send for the newly published booklet describing these alloys. Write to Haynes Stellite Company, Distribution Section, 30-20 Thomson Avenue, Long Island City, N. Y.



Concentrated Sulphuric Acid flows across perforated trays made of HASTELLOY alloy B in these drying towers. Alloy B resists the corrosive effect of the acid and helps maintain the efficiency of the tower. The trays have been in use since 1949.

HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation

Kokomo, Indiana

UNION CARBIDE

"Haynes," "Hastelloy" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

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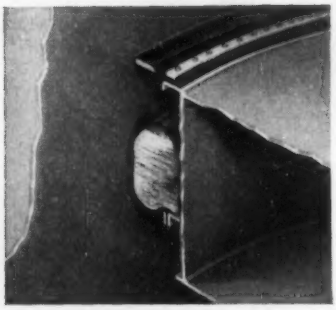
every oil operator wants to know

HOW TO PREVENT LIGHTNING FIRES IN TANKS

the answer is now available

USE HAMMOND TUBESEAL* FLOATING ROOFS!

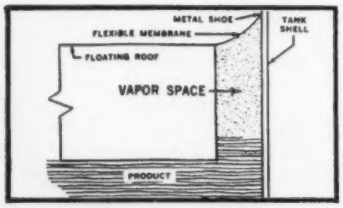


TUBESEALS are made lightning-proof with their exclusive electric conductor weather seal.[1] This specially compounded synthetic rubber, extending continuously around the entire perimeter, between roof and tank shell, provides an infinite number of contact points. ELABORATE TESTING by an independent laboratory[2] discloses that the seal prevents isolation and collection of static electricity charges, providing a continuous conductive surface with large current carrying capacity. Induced charges from lightning are immediately dissipated and fires are prevented. There are no mechanical contacts to cause sparking.

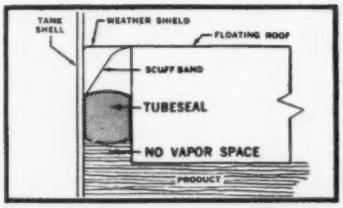
WITHOUT VAPOR THERE CAN BE NO FIRES. . . **the inherent design and construction of Hammond Tubeseals eliminates space between roof, shell, and liquid; thus, there is no room for vapor to form . . . no vapor . . . no fires . . . no evaporation . . . no corrosion!**

Introduced to the oil industry late in 1955, the Hammond Tubeseal found immediate favor with oil companies all over the world . . . there are now more than 200 installations in operation and building. A measure of their conservation values and fireproof features is illustrated by their record of repeat orders from satisfied users—one large oil company, after several test installations, re-ordered more than a score of Tubeseals. The same story of satisfaction exists wherever a Tubeseal is in operation.

Write for bulletin TS



CONVENTIONAL FLOATING ROOF tank has space below flexible membrane where air-vapor mixtures form. Because metal shoe and membrane cannot be absolutely gas tight, vapor is constantly escaping. This condition causes excessive corrosion, may also result in rim fires from lightning or other source.



HAMMOND TUBESEAL FLOATING ROOF entirely eliminates every space where air-vapor mixtures can form. Hammond Tubeseal completely fills space between product surface and roof seal, so that corrosion is stopped (even for sour crudes), and vapor cannot form—hence cannot ignite or be lost.

THE HAMMOND TUBESEAL
for new or old floating roof tanks,

FEATURES

- **lightning and fire proof construction**
- **no moving parts**
- **no mechanical maintenance**
- **climate-proof**
- **non-corrodible**
- **can operate to bottom of tank or above the top**
- **no vapor space below the seal**
- **entire circumference has tight seal under pressure at all times**
- **longer working life expectancy**

*Patented [1]patent pending [2]names on request

HAMMOND TUBESEAL — THE MOST EFFICIENT AND POSITIVE SEAL KNOWN

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Specification, Design, Fabrication Data on Aluminum Tanks and Vessels

Now complete information is available—from Reynolds Aluminum—on the specification, design and fabrication of aluminum for tanks and vessels.

A new brochure, "Reynolds Aluminum for Tanks and Vessels" gives the engineer and designer:

1. A comprehensive list of products which can be satisfactorily stored or handled by aluminum.
2. Specific design data and formulas for use of aluminum in tanks and vessels.
3. Tables on the factors to be considered in design: allowable stress values in tension, allowable efficiencies for arc and gas welded joints, stresses, gauge requirements, etc.
4. Fabrication data and considerations.

Aluminum is the ideal metal for a host of process shipping and storage tank applications: it resists corrosion well, it costs less than other corrosion-resistant metals, it is non-sparking, it has ideal thermal properties, it is easy to fabricate and weighs ⅓ as much as steel.

Learn how to take advantage of these properties, with Reynolds new authoritative brochure, "Reynolds Aluminum for Tanks and Vessels". Send in the coupon below, today . . . or call your local Reynolds office.

Watch Reynolds All-Family Television Program "DISNEYLAND", ABC-TV.

The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

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Please send me a copy of your brochure, "Reynolds Aluminum for Tanks and Vessels".

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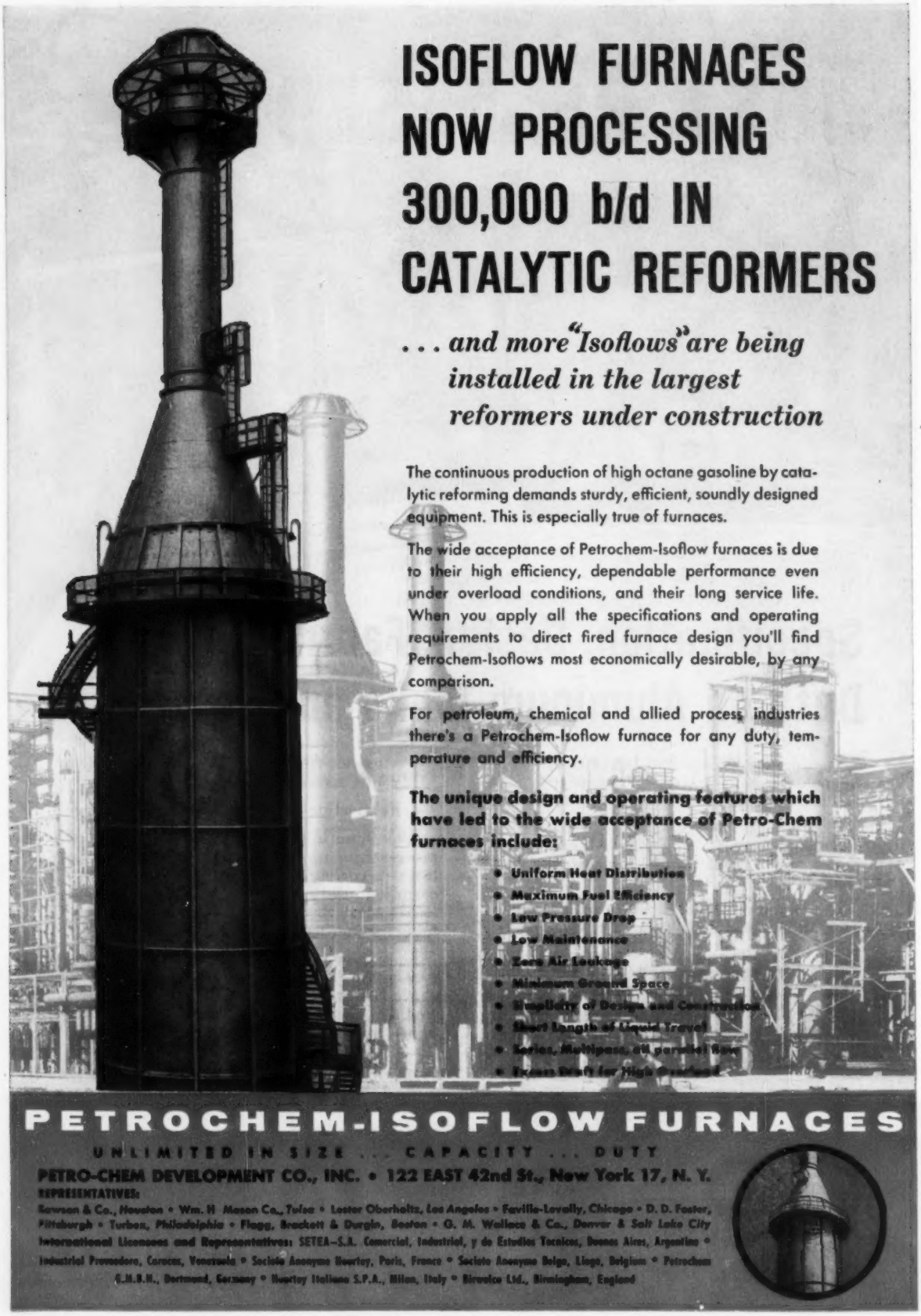

ISOFLOW FURNACES NOW PROCESSING 300,000 b/d IN CATALYTIC REFORMERS

. . . and more "Isoflows" are being installed in the largest reformers under construction

The continuous production of high octane gasoline by catalytic reforming demands sturdy, efficient, soundly designed equipment. This is especially true of furnaces.

The wide acceptance of Petrochem-Isoflow furnaces is due to their high efficiency, dependable performance even under overload conditions, and their long service life. When you apply all the specifications and operating requirements to direct fired furnace design you'll find Petrochem-Isoflows most economically desirable, by any comparison.

For petroleum, chemical and allied process industries there's a Petrochem-Isoflow furnace for any duty, temperature and efficiency.

The unique design and operating features which have led to the wide acceptance of Petro-Chem furnaces include:

- Uniform Heat Distribution
- Maximum Fuel Efficiency
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- Simplicity of Design and Construction
- Short Length of Liquid Travel
- Series, Multipass, all parallel flow
- Excess Draft for High Overload

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UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

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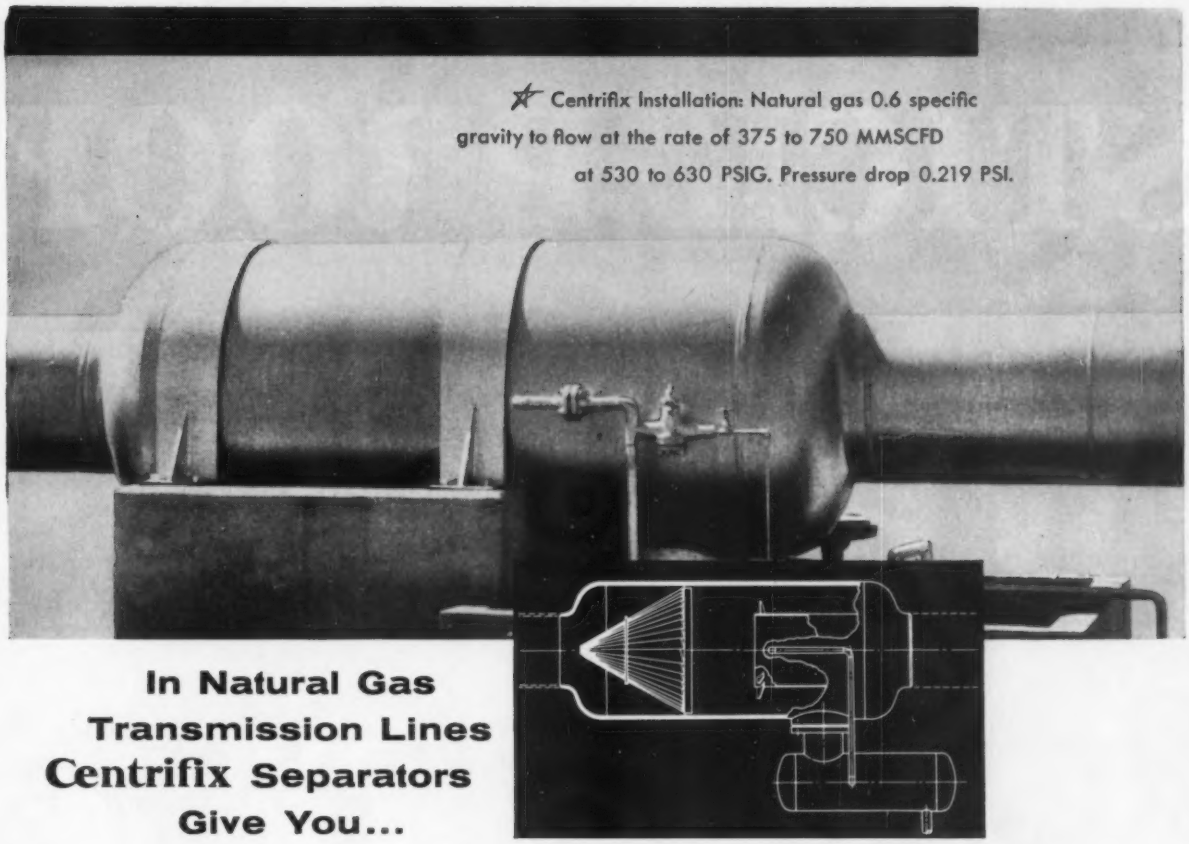
★ Centrifix Installation: Natural gas 0.6 specific
gravity to flow at the rate of 375 to 750 MMSCFD
at 530 to 630 PSIG. Pressure drop 0.219 PSI.

In Natural Gas Transmission Lines Centrifix Separators Give You...

Low First Cost • Maximum Efficiency • Fool-proof Operation • No Maintenance

The removal of dust, fine solids and entrained hydrocarbons is accomplished with ease when you standardize on Centrifix Separators in your natural gas transmission lines.

Only the Centrifix Separator because of its exclusive basic design incorporating the proper application of controlled centrifugal and centripetal high-velocity forces achieves maximum separating efficiency. This result is produced by the Centrifix Helicoid Tuyere and Vortex Breaker.

The illustration above shows one of six recent Centrifix installations that have gone into the gas transmission lines of one company. Notice that it is a horizontal installation, the maximum length is small (being 12′ 6″ overall) and does not require the ordinary or conventional use of multiple vertical scrubbers with all their incidental piping and valves.

A Centrifix purifying equipment specialist will be glad to discuss your problems.

Write today for Centrifix Engineering Manual and Catalog.

THE
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CORPORATION
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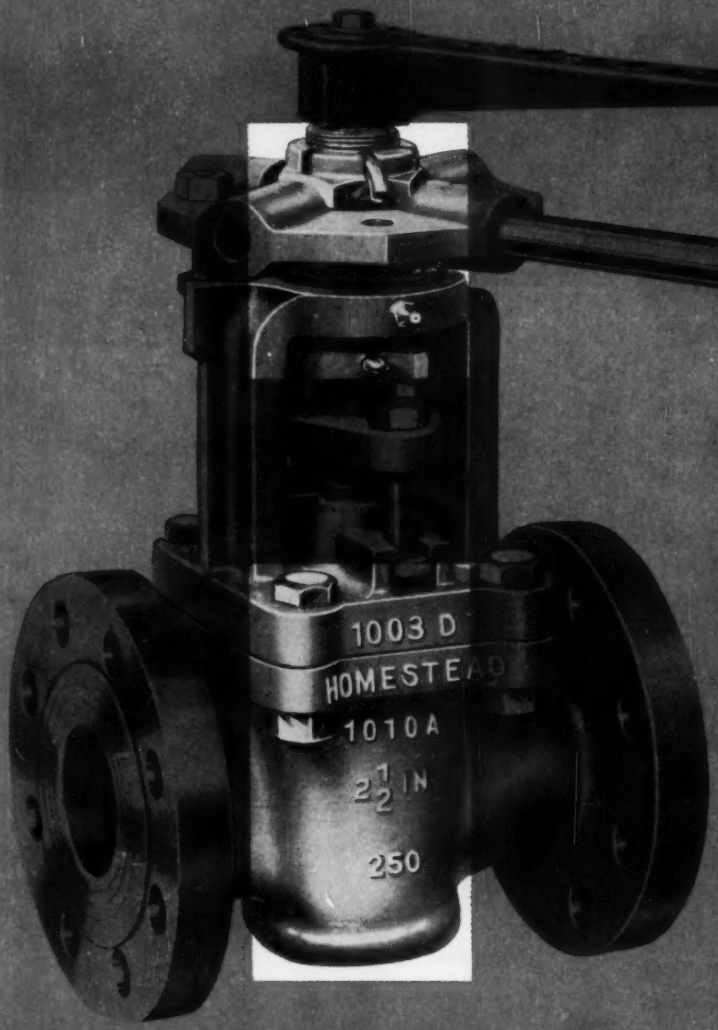
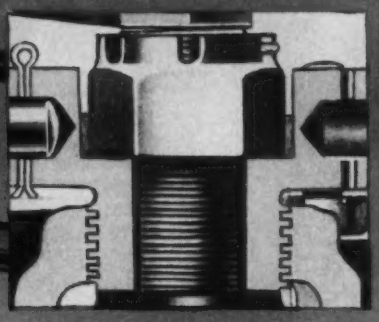
In the spots that count... Homestead® Valves are

STICK-PROOF





Built-in lever and screw affords instant operation

Seating pressure is mechanically relieved for easy turning

TROUBLE-FREE SERVICE is assured under all fluid, temperature and pressure conditions by the exclusive design of Homestead Lever-Seald Valves.

Instant stick-proof operation is guaranteed by a built-in lever and screw which mechanically relieves seating pressure. This controlled relief of pressure is only sufficient to overcome friction and to permit the plug to turn freely. What's more, all operating parts are protected from the damaging effects of corrosive or erosive service conditions and are completely weatherproof.

Write today for fully detailed Reference Book 39—Section 3. See for yourself how Homestead Lever-Seald Valves can solve your problems on high temperature, pressure or corrosive services.

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why is Caposite so strong?

It's no secret why CAPOSITE insulation is so strong and stands up to such rough usage. These pipe sections and blocks are made wholly of Amosite asbestos and the long fibres of this particular kind of asbestos give CAPOSITE its strength and resilience as well as its high insulating value. This exceptional strength leads to many other features besides long life; it means that larger sizes of pipe sections and blocks are possible, making application easier and faster. Less care is needed in handling the material. Unlike other moulded insulation, CAPOSITE, because of its strength, can be shipped to refineries anywhere in the world *in cardboard cartons*, showing big savings in freight and storage costs.

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for the Petroleum Industry

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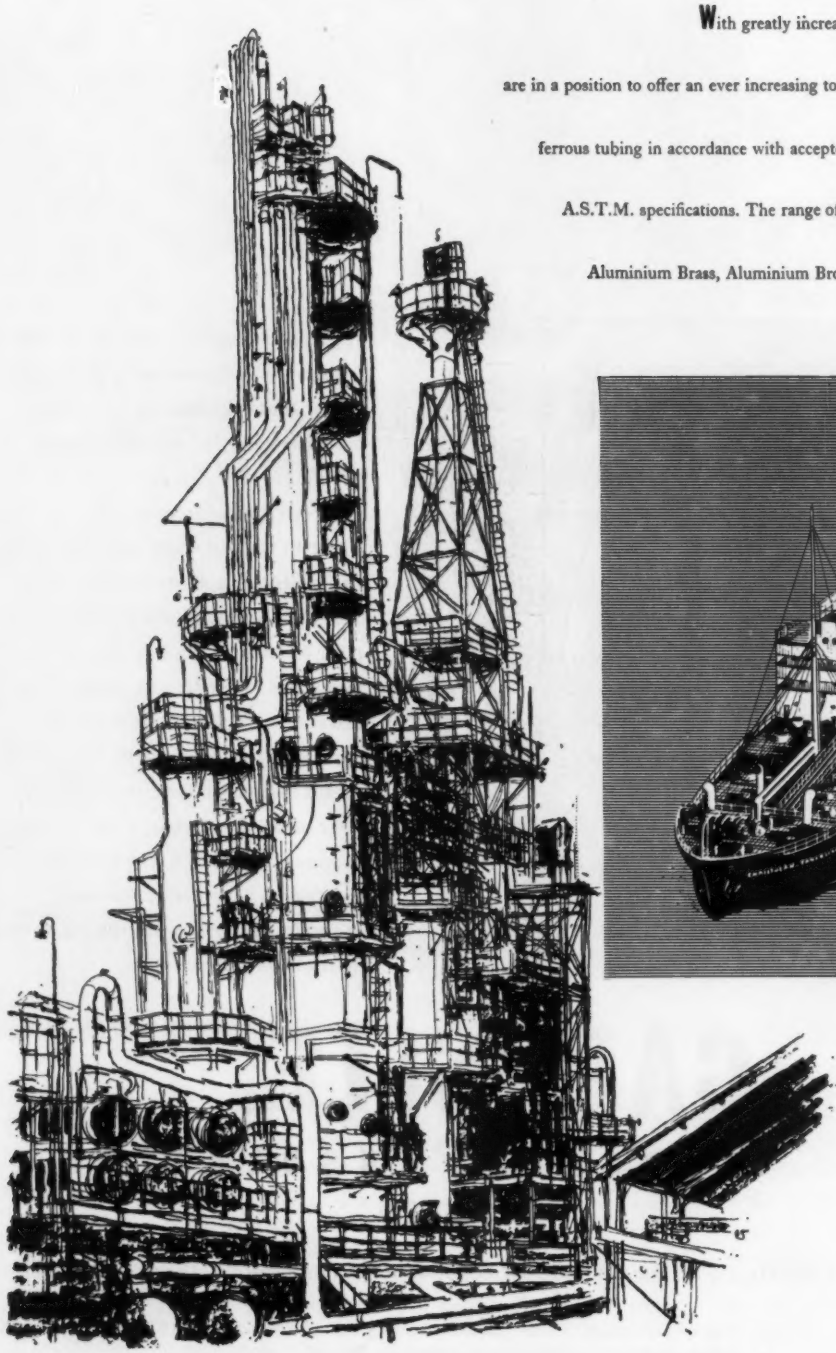

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U. S. CONTRACTORS WITH OFF-SHORE CONTRACTS CAN SAVE REAL MONEY
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OPEN STEEL FLOORING
BECAUSE:
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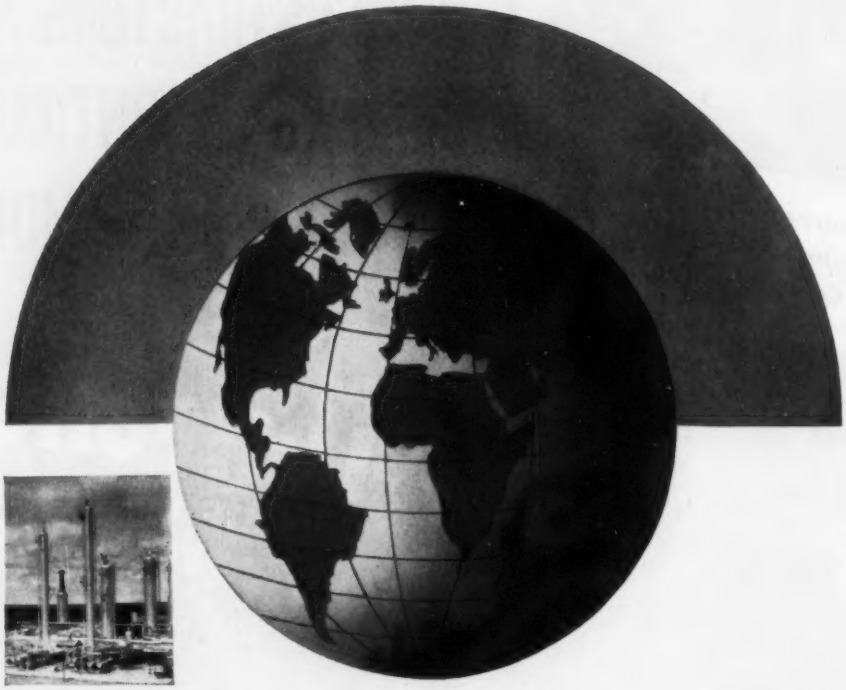
ON COVERING THE WORLD . . .



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From the early days of "Boiler Covering" Newalls have been foremost in the development of industrial insulation techniques.

In almost every country, meeting all types of climatic and working conditions, are installations on which Newalls' Insulation has for many years given maximum heat conservation and temperature control.

With an international contracting organisation and time-proved materials including Newalls (Reg'd. Brand) 85% Magnesia, Nicosil, Newtempheit and Amosite Asbestos, Newalls provide an insulation service ensuring peak operating efficiency in Oil Refineries and Petro-Chemical plants.

Newalls (REG'D BRAND)

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Here's Refrigeration Designed For Every Basic Oilfield Application!

...It's The New BS&B "COLD-FRAC*" Ammonia Absorption Refrigeration Unit

OUTSTANDING FEATURES:

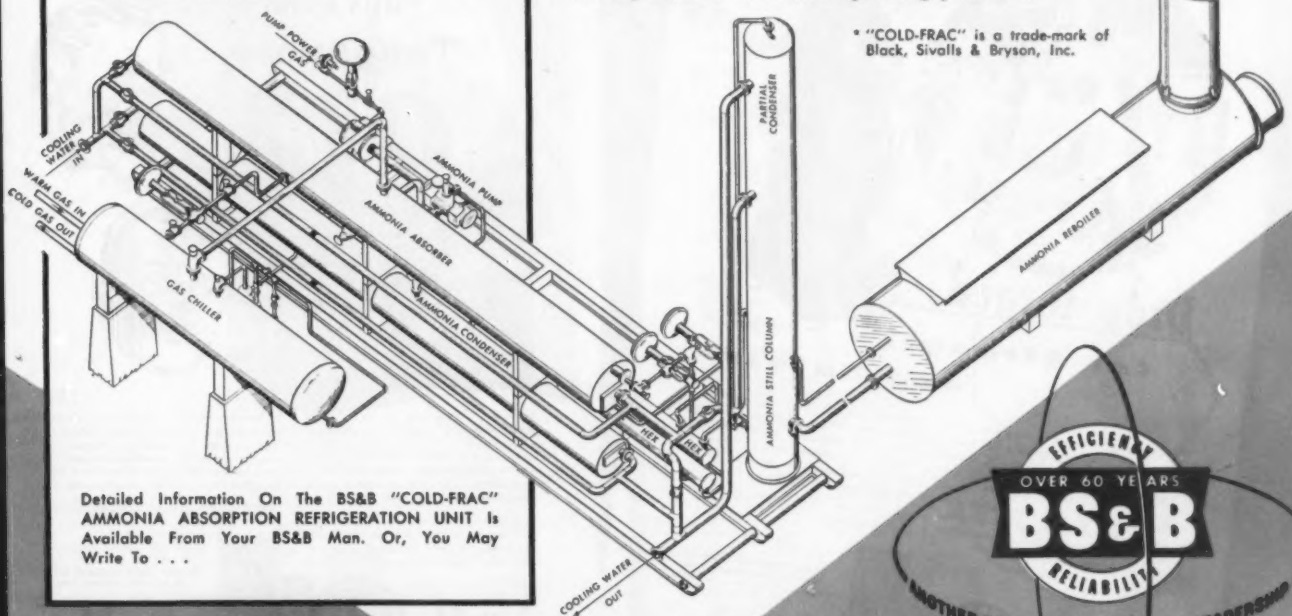
1. **Entirely Self-Operating.** Automatically Adjusts to Load Changes.
2. **Low Initial Cost.** Unit May Be Skid-Mounted Except Ammonia Reboiler. Outside Construction — No Buildings Required.
3. **Low Cost Maintenance.** Liquid Pump Is The Only Moving Part.
4. **Operating Costs Vary.** In Direct Proportion To The Load.
5. **Lower Operating Temperatures** Do Not Materially Decrease Capacity.
6. **Completely Closed System.**
7. **Chiller "Slop Over" Of Liquid Refrigerant Causes No Problem.** (There is no compressor to cause worry about liquids in the suction.)
8. **Oil Lubrication Eliminated.** No Oil-Refrigerant Problem.
9. **Vibration Free.** No High Speed Reciprocating Machinery To Mount.
10. **Experts Are Not Required** To Operate and Maintain The Unit.

With the development of BS&B's new "COLD-FRAC" AMMONIA ABSORPTION REFRIGERATION Unit, the oil industry now has a simple, non-mechanical, heavy duty artificial refrigeration system which is applicable to any oilfield or refining process requiring temperatures below ordinary atmospheric level.

A few examples of immediate industry applications are:

1. **Gas Pipeline Companies — For The Elimination Of Liquids In Gas Transmission Lines Through Better Hydrocarbon Dewpoint Control.**
2. **Gasoline Plants — For The Chilling Of Absorption Oil To Increase Hydrocarbon Recoveries Without Installing Larger Absorption Oil Towers Or Pumps.**
3. **Lease Production — To Provide Essential Refrigeration For Maximum Hydrocarbon Recovery Where Sufficient Pressure Expansion Is Not Available. Also To Supplement Declining "Natural" Refrigeration.**

These Ammonia Absorption Refrigeration Units are built for rugged, heavy duty, 365 day-per-year continuous operation, and are available in eleven standard sizes. Completely automatic in operation, they are equipped with BS&B oilfield-type controls and motor valves which are already familiar to oilfield operating personnel.



* "COLD-FRAC" is a trade-mark of Black, Sivalls & Bryson, Inc.

Detailed Information On The BS&B "COLD-FRAC" AMMONIA ABSORPTION REFRIGERATION UNIT Is Available From Your BS&B Man. Or, You May Write To . . .

EFFICIENCY
OVER 60 YEARS
BS&B
RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

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For wider adaptation . . . and unmatched Service Life . . . . . the New

Vogt GENERAL GP PURPOSE VALVES

* GP Valves completely fill the demands of industry for a line of compact, lighter weight, shorter face-to-face valves.

Still retaining the safety and ruggedness inherent in a wrought material, these new forged steel screw and socket weld end valves, in sizes from ⅛" through 2", are rated 800 pounds at 850°F and 2,000 pounds at 100°F.

We invite you to inquire into the savings which the new line of Vogt GP Drop Forged Steel Valves can make possible in your operations. Not only do their many unique and exclusive features make them more economical of operation, but their broad adaptability to so many industrial applications permits a substantial reduction in operating overhead. Service life, too, is enhanced with Stellite faced seating surfaces which are available at no extra cost along with many other trims.

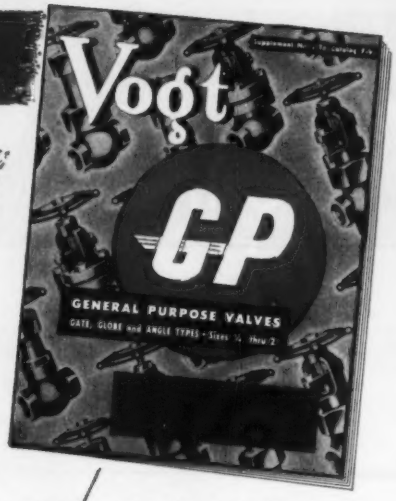
150-800 Pounds Service
(2000 pounds cold)

•

Featuring Stellite Faced Seating Surfaces

•

Sizes ¼" to 2"



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Louisville, Kentucky

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FREE
Supplement No. 1 to Vogt Catalog F-9

This 32-page catalog illustrates and gives complete specifications on 11 types of the new Vogt GP forged steel gate, globe and angle valves. Send for your free copy — for ready reference in purchasing. Use the coupon for convenience.

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Gentlemen: *Please send copy of New Vogt Catalog Supplement No. 1 to . . .*

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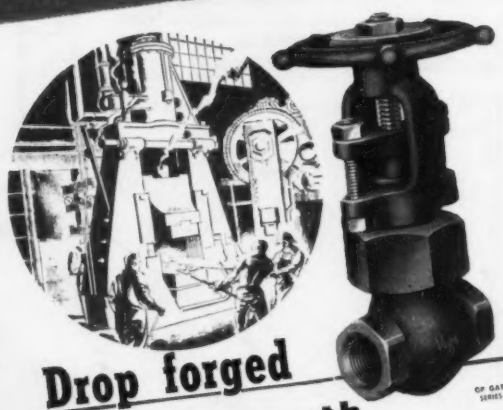
. . . . these ads tell you why



Drop forged for Strength and Safety

GP GATE VALVE SERIES 5-9530

Drop forging techniques, resulting from more than a half century of pioneering and development by Vogt in the production of forged steel valves, impart matchless strength and safety to the new line of Vogt GP Valves. Made from killed, clean, fine grained open hearth steel billets, forging and treatment operations result in additional grain refinement and increased toughness.

GP Valves are setting new standards of performance in petroleum refineries, chemical plants, power plants, and related industries. Available in a complete range of sizes from ⅛" to 2" and rated 800 pounds at 850°F. and 2000 pounds at 100°F.

Advt. No. 4 in a series describing the features of Vogt GP Valves.

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Vogt GENERAL GP PURPOSE DROP FORGED STEEL VALVES

Tough valve buyers appreciate this kind of . . . Toughness

*HAYNES STELLITE

Here's why:—They know that to foil those troublesome valve "termites"—erosion, corrosion, and galling—requires built-in toughness which only seats faced with hard facing alloys AND hardened wedges can provide. Yes, it takes BOTH to do a real job and GP Valves provide both at no extra cost!

Vogt GP Valves feature the toughest and, since they are precision finished, the smoothest seating surfaces obtainable anywhere. That's why they are setting new standards of performance—longer, drop-tight service with minimum, low cost maintenance—in petroleum refineries, chemical plants, power plants and other industries. Available in a complete range of sizes from ⅛" to 2" and rated 800 pounds at 850°F. and 2000 pounds at 100°F.

Advt. No. 5 in a series describing the features of Vogt GP Valves.

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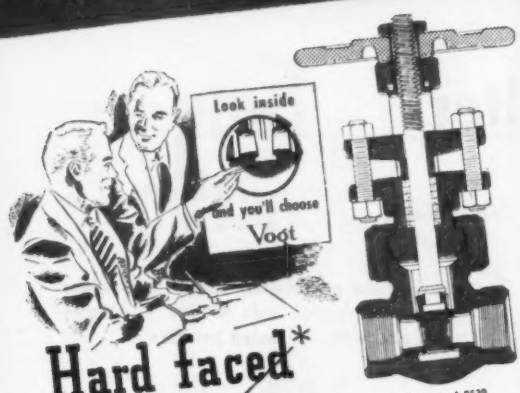
Vogt GENERAL GP PURPOSE DROP FORGED STEEL VALVES

HAYNES STELLITE—Trade-mark of Union Carbide and Carbon Corporation



Hard faced* Seating

. . . at no extra cost!

STELLITE *faced seating surfaces* are among the many plus advantages offered by Vogt General Purpose Valves. Fusion welded to the removable stainless steel seat rings of gate valves and to the integral seat of globe and angle valve bodies, tough, long-wearing STELLITE affords amazing resistance to erosion, corrosion and galling.

The new line of Vogt drop forged steel GP's completely fills the demands of industry for a line of compact, lighter weight, shorter face-to-face valves. They assure operation economies and longer life and are available in a complete range of sizes and types from ¼" to 2". They are rated 800 pounds at 850° F. and 2,000 pounds at 100° F. Send today for free catalog.

Adv. No. 2 in a series describing the features of Vogt G-P Valves.

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Vogt GP GENERAL PURPOSE DROP FORGED STEEL VALVES

G-P series S-9530

Hard faced WITH STELLITE * to resist seat wear

. . . at no extra cost!

GP Globe Valve-Series 800

Stubborn resistance to valve seat wear, due to erosion, corrosion and galling, is built into Vogt GP valves with Stellite faced seating surfaces used in conjunction with hardened discs and wedges. By an exclusive method, hard facing alloys are welded to the integral seat of globe and angle valve bodies and to the removable stainless steel seat rings of gate valves.

This important feature, available at no extra cost, assures operation economies and longer valve life. A catalog describing the complete General Purpose line of valves in sizes ¼" to 2" will be sent on request.

Adv. No. 3 in a series describing the features of Vogt GP valves.

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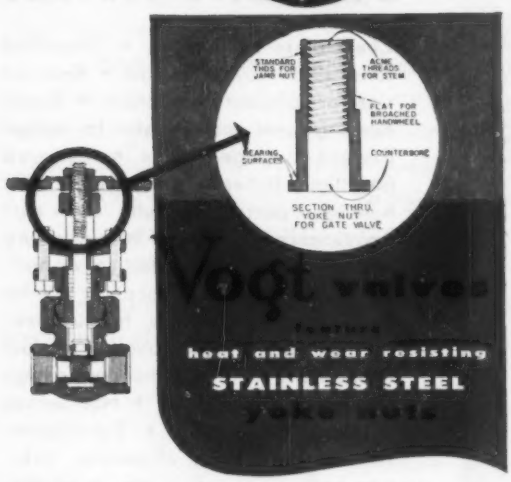
Vogt GP GENERAL PURPOSE DROP FORGED STEEL VALVES

*TYPES STELLITE—Trade mark of Union Carbide and Carbon Corporation

VOGT GP GENERAL PURPOSE valves are better



Heat and wear-resisting *stainless steel* yoke nuts in Vogt Valves give longer trouble-free service. We have proved this in our own "Torture Chamber," under constant and accelerated testing, as well as in tough service applications. They are made from a special stainless steel alloy having excellent bearing quality, matchless strength, and a melting point of approximately 2700° F.

The rotating gate valve yoke nut design, illustrated, has flats for a tight fit with the square broached hole of the handwheel. Non-rotating yoke nuts, for globe and angle valves, are of the same superior design and quality. Vogt GP Valves are available in a complete range of sizes from ½" to 2" and rated 800 pounds at 850° F. and 2000 pounds at 100° F.

Adv. No. 6 in a series describing the features of Vogt GP Valves.

Write for Your FREE COPY of Supplement No. 1 to Catalog F-5 Address Dept. 24-FC

HENRY VOGT MACHINE CO.
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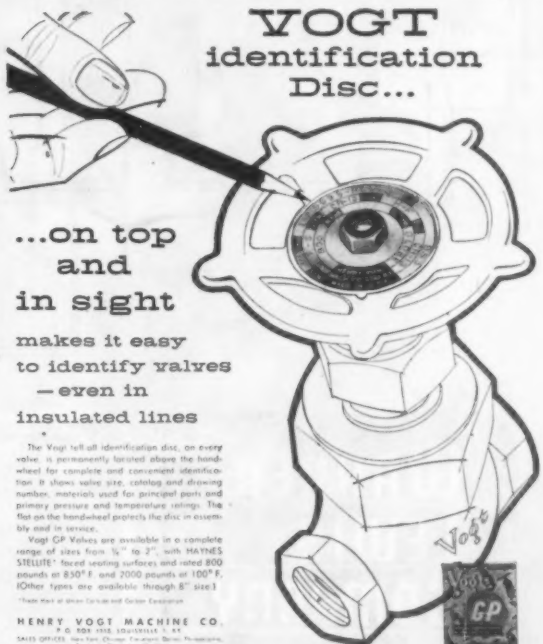
Vogt GP GENERAL PURPOSE DROP FORGED STEEL VALVES

VOGT identification Disc...



...on top and in sight

makes it easy to identify valves —even in insulated lines

The Vogt tell-all identification disc, on every valve, is permanently located above the handwheel for complete and convenient identification. It shows valve size, catalog and drawing number, materials used for principal parts and primary pressure and temperature ratings. The flat on the handwheel protects the disc in assembly and in service.

Vogt GP Valves are available in a complete range of sizes from ½" to 2", with HAYNES STELLITE* faced seating surfaces and rated 800 pounds at 850° F. and 2000 pounds at 100° F. (Other types are available through 8" size.)

*Trade Mark of Union Carbide and Carbon Corporation

HENRY VOGT MACHINE CO.
P. O. BOX 1918, LOUISVILLE 1, KY.

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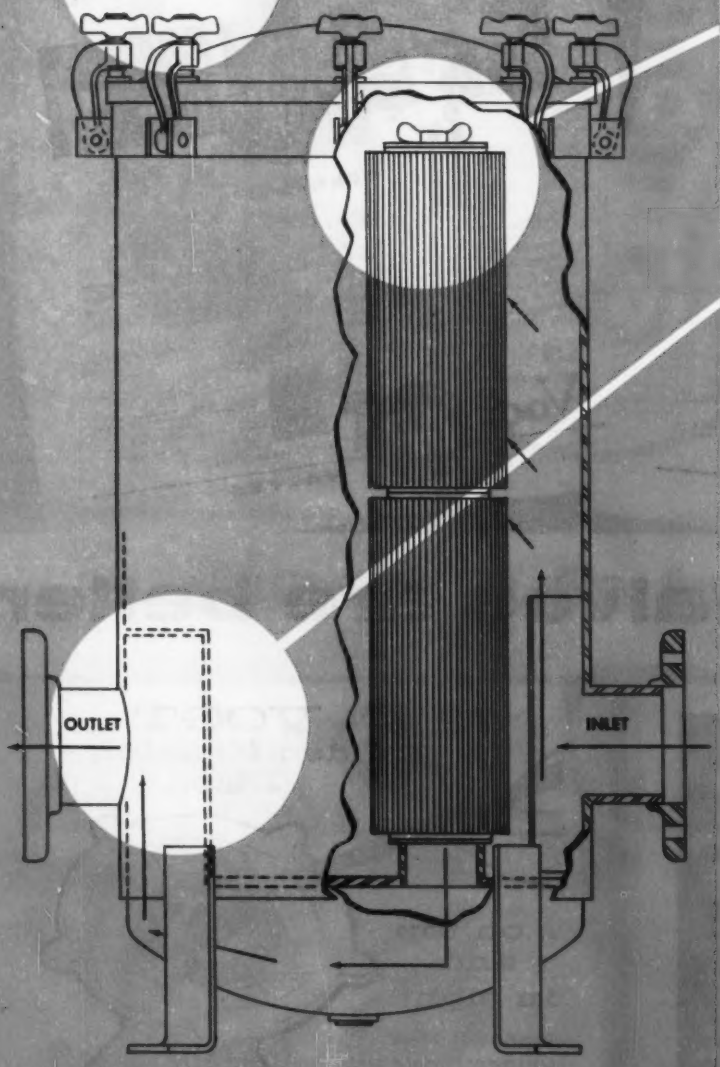
Vogt GP GENERAL PURPOSE DROP FORGED STEEL VALVES

Adv. No. 7 in a series describing the features of Vogt GP Valves.

NOW! In ONE Filter



Easy Servicing

Just a twist of the wrist and the top swings open. No special tools needed; eliminates nuts and bolts; no busted knuckles.

Best Performance

PETROLEUM MARKETING FACILITIES: truck loading racks, aircraft fueling, fuel oil bulk plants.

MACHINE TOOLS: coolants and cutting oils, hydraulic oils.

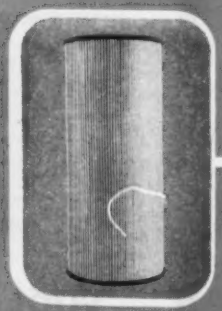
INDUSTRIAL PLANTS: solvents, oils, water and other non-corrosive fluids.

WITH THE

New Excel-So

57 SERIES FILTERS

Check these advantages • Simplified construction—low initial cost • Reduced size for compact installation • Quick opening cover and provision for instantaneous cartridge change • Improved filtration efficiency and greater dirt holding capacity . . . result . . . low cost maintenance • Very low initial pressure drop • Available for vertical or horizontal installation • Location of inlet and outlet connections to customer specifications • Wide range of product applications • Units in standard design or for code requirements • Non-ferrous construction available • Extra accessories including air eliminator, pressure gage, dump valve, etc., available.



CH-57PL
PLEATED CARTRIDGE

THE NEWLY Developed
CH-57PL Cartridge combines

- Larger Outside Diameter
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- Greater Height

RESULT

- More Filtration Surface
- Lower Operating Cost
- Higher Flow Rates

WARNER LEWIS COMPANY

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DIVISION OF FRAM CORPORATION
Representatives in all major cities
In Canada: FRAM CANADA LTD., Stratford, Ontario

Write for bulletin WL-6-56

Smith "Figure 815"
Flanged End Gate Valve

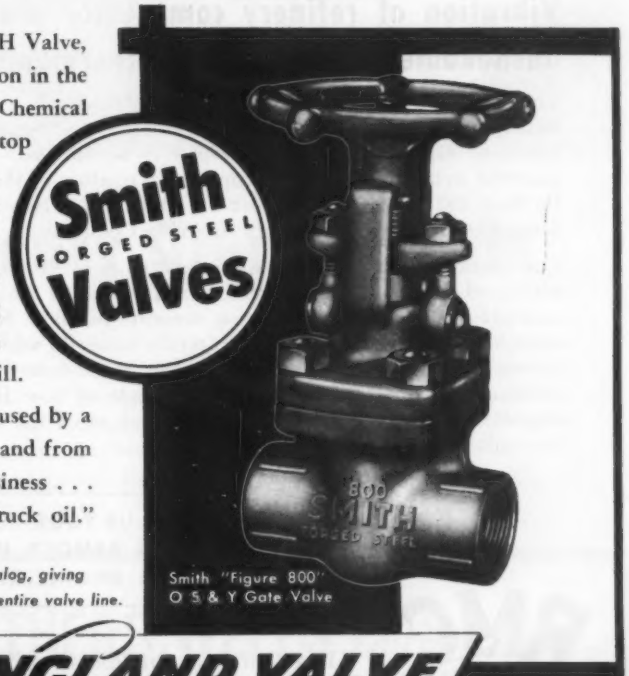
Smith "Figure 850"
Inside Screw Valve

we sure had to "DIG" ...but we struck OIL!

Before we even started to design a SMITH Valve, we spent many a day "digging" for information in the engineering departments of the Refinery, Chemical and Petrochemical Industries. We consulted with the top Material and Specification Engineers, Process Piping Engineers and Operating and Maintenance Engineers of these industries. We took their suggestions and designed SMITH Valves to include the features they specified. We built our valves according to the most exacting standards of accuracy, high quality of materials and manufacturing skill.

Judging from the fact that SMITH Valves are now used by a large portion of the major companies in these industries, and from the continuous flow of day-to-day repeat business . . . we think we have "struck oil."

Write today for our new catalog, giving complete information on our entire valve line.



Smith "Figure 800"
O S & Y Gate Valve

NEW ENGLAND VALVE Corporation

P. O. BOX 1047 • WORCESTER, MASSACHUSETTS

West Coast Distributors: BETHLEHEM SUPPLY CO., LOS ANGELES, CALIFORNIA

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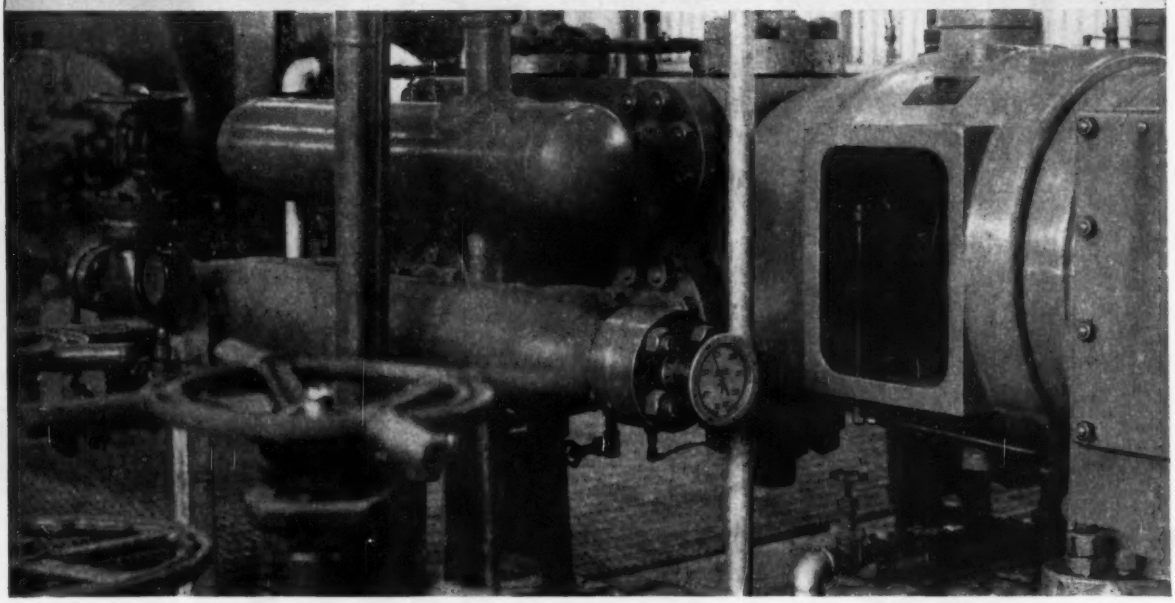
VIBRATION



Vibration of refinery compressor proves unshakable accuracy of RMC thermometer

The RMC Thermometer shown in the photograph is constantly subjected to extreme vibration from the two-stage Synthesis Gas Compressor on which it is installed. This powerful equipment is used to compress a mixture of H_2 and N_2 from 400 to 3500 pounds—at the Philadelphia Synthetic Ammonia Plant of The Atlantic Refining Company.

This particular job required a special thermometer that could withstand the constant and terrific vibration, and at the same time provide and maintain precise, accurate readings. Rochester Manufacturing Company promptly came up with the answer—a silicone-dampened, bimetallic, angle-form RMC thermometer. And this is but one example of how RMC engineering skill provides instruments that meet the most demanding and exacting requirements.

Look to RMC for Full-Line Instrumentation

DIAL THERMOMETERS

Illustrated here is a 6" dial thermometer with hermetically sealed dial chamber, external recalibration—built for heavy duty service. What are your thermometer requirements?

PRESSURE SWITCHES

This RMC Pressure Switch will stand heavy pulsating pressures, has close on-off differentials, maintains consistent cut-in, cut-out settings. What are your pressure switch problems?

TELL US YOUR REQUIREMENTS FOR DIRECT MOUNTING AND REMOTE INDICATING INSTRUMENTS, AND LET RMC ENGINEERING SKILL PROVIDE THE ANSWERS!

REPRESENTATIVES IN ALL PRINCIPAL CITIES

RMC

"You Can Rely On Rochester"

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

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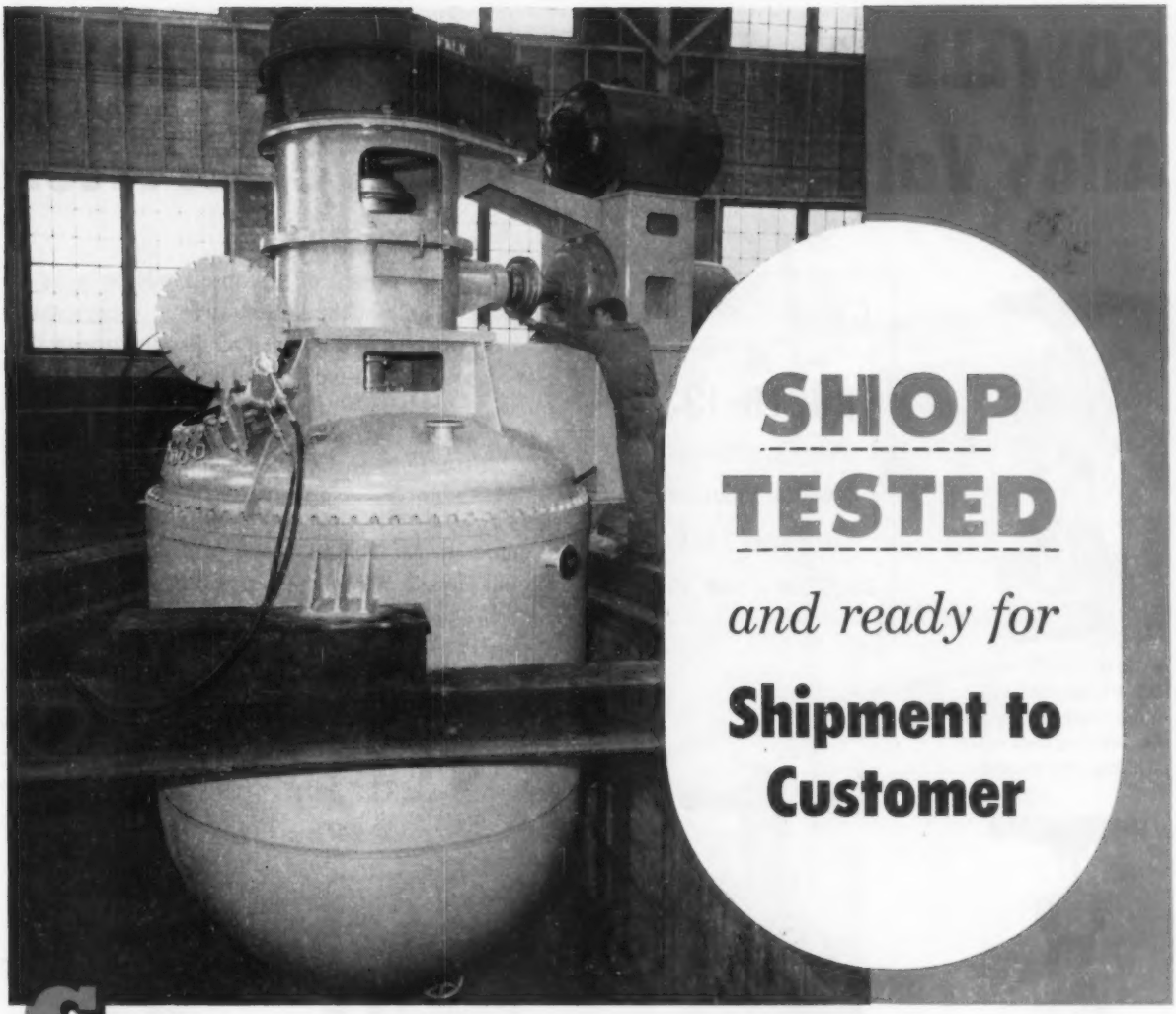
ROCHESTER MANUFACTURING CO., INC.
38 ROCKWOOD STREET • ROCHESTER 10, N.Y.



SW's High Efficiency Grease Kettle

This 200 hp Struthers Wells Grease Kettle, shown being checked out at the SW Plant, represents a new design principle which permits heavy horsepower input, counter-rotating de-stratifying arms for "double motion" efficiency, plus hinged scraper blades for ultimate heat transfer. For greater production efficiency for all types of greases, let us design an SW *Double Motion* Kettle to your requirements.

STRUTHERS WELLS PRODUCTS

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Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

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STRUTHERS WELLS *Corporation*

WARREN, PA.

Struthers Wells

Plants at Warren, Pa. and Titusville, Pa.

Offices in Principal Cities

POWELL—the most complete line of Alloy Valves* for Corrosive Services

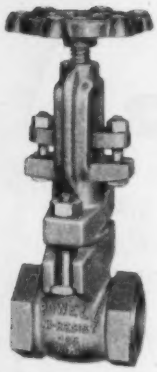


Fig. 2194—Small Ni-Resist. O.S. & Y. Gate Valve for 225 W.O.G. Larger sizes, flanged end, and swing check valves in Ni-Resist also available.

Come... see us
at
BOOTH 133
26th Exposition of
Chemical Industries
December 2 to 6
COLISEUM - NEW YORK

It's a fact . . . Powell offers more kinds or types of valves, available in the largest variety of corrosion-resistant metals and alloys, to handle practically every known corrosive fluid. The complete line includes gates, globes, angles, checks, "Y's", relief, flush bottom tank valves and others—for pressures from 150 to 1500 WP. A few are shown on this page.

Your local valve distributor will be glad to tell you all about them. If none is near you, write to us for the full facts on Powell Valves and Powell Engineering Service.

THE WM. POWELL COMPANY
Dependable Valves Since 1846
CINCINNATI 22, OHIO

**Powell Alloy (Corrosion Resistant) Valves are available with screwed or flanged ends. Flanged end valves conform to latest standards.*

Fig. 1832—Stainless Steel Gate Valve for 200 W.P. Screwed-in bonnet, inside screw rising stem, solid wedge disc.

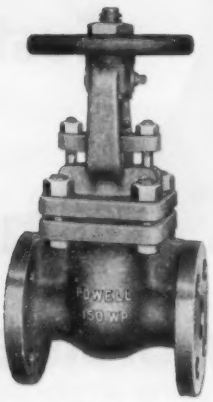


Fig. 2491—Stainless Steel Gate Valve for 150 W.P. Outside screw rising stem and yoke, solid wedge disc. Can be supplied with interchangeable split wedge disc

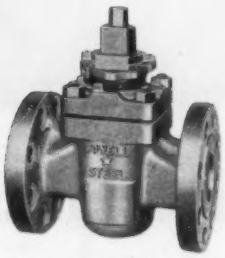


Fig. 1559—Steel Lubricated Plug Valve for 200 W.O.G. Screwed gland type. 6" and larger valves can be furnished for gear operation.

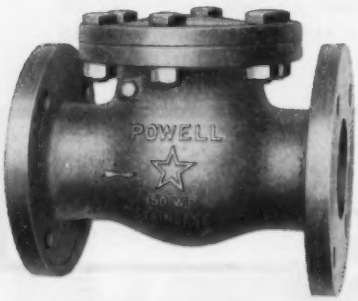


Fig. 2433SS—Large size Stainless Steel Swing Check Valve for 150 W.P. Bolted Cap.

Fig. 2107—Stainless Steel "Y" Valve for 150 W.P. Plug type disc. Face to face and end flange dimensions conform to latest standards.

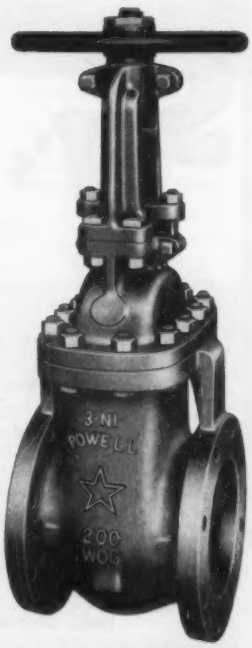
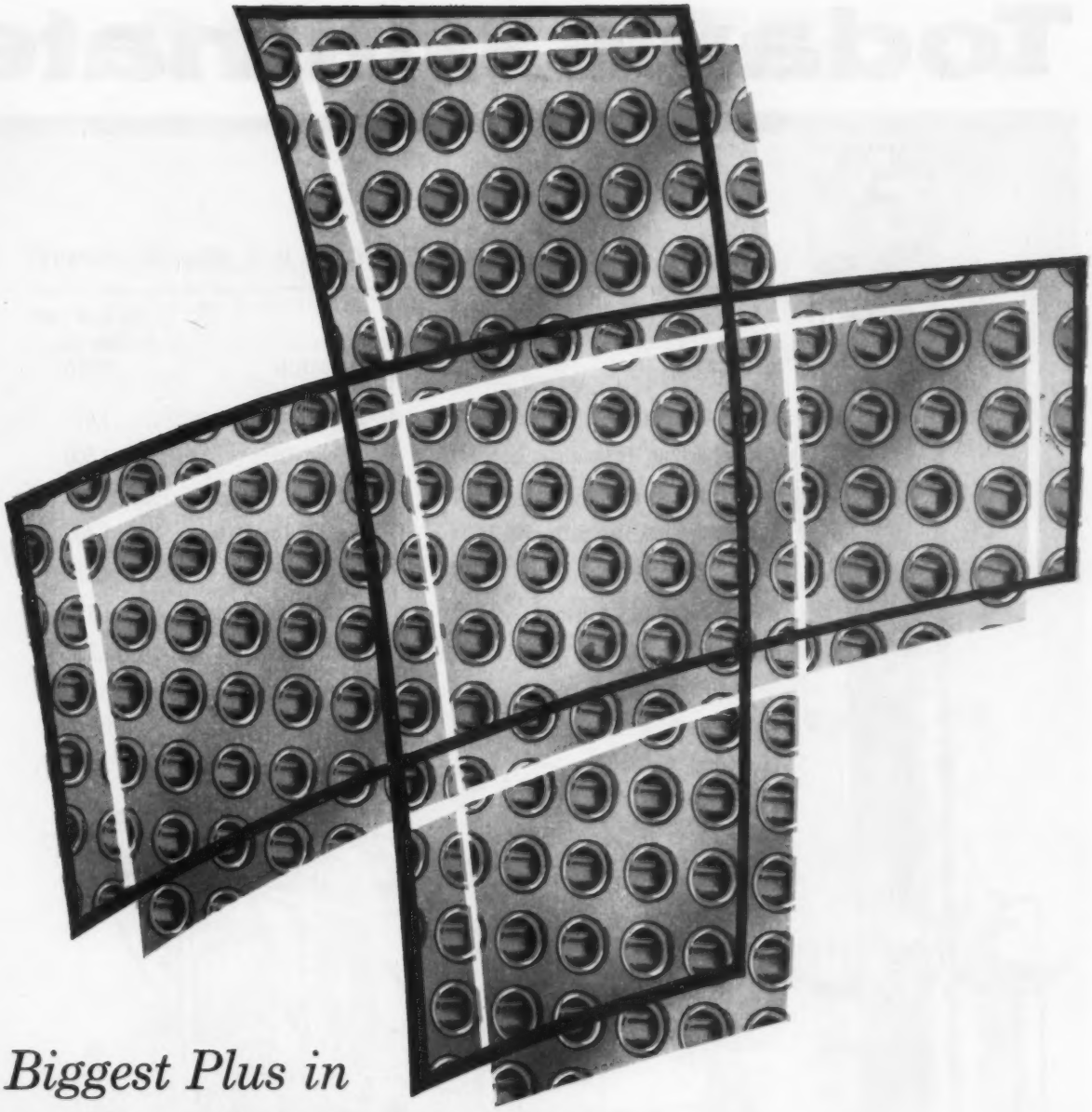


Fig. 1893—Large O.S. & Y. Gate Valve for Paper Mill Service. 3% Nickel Iron Body, bonnet, yoke; stainless steel stem, screwed-in seat rings; Ni-Resist wedge.



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HEAT EXCHANGER TUBE *life...*

CHASE® *dependability!*

Dependability is more than just a word with Chase. It's a reality! Or, rather, one hundred and twenty million pounds of reality. That's roughly how much Chase Antimonial Admiralty has been put into service since 1935—without a single reported dezincification failure! What does it mean? Simply this: superior corrosion resistance under adverse conditions...far fewer equipment breakdowns...extra years of money-saving service. Each a profitable plus! See! Today write for your free 54-page manual: "*Chase Condenser and Heat Exchanger Tubes.*"

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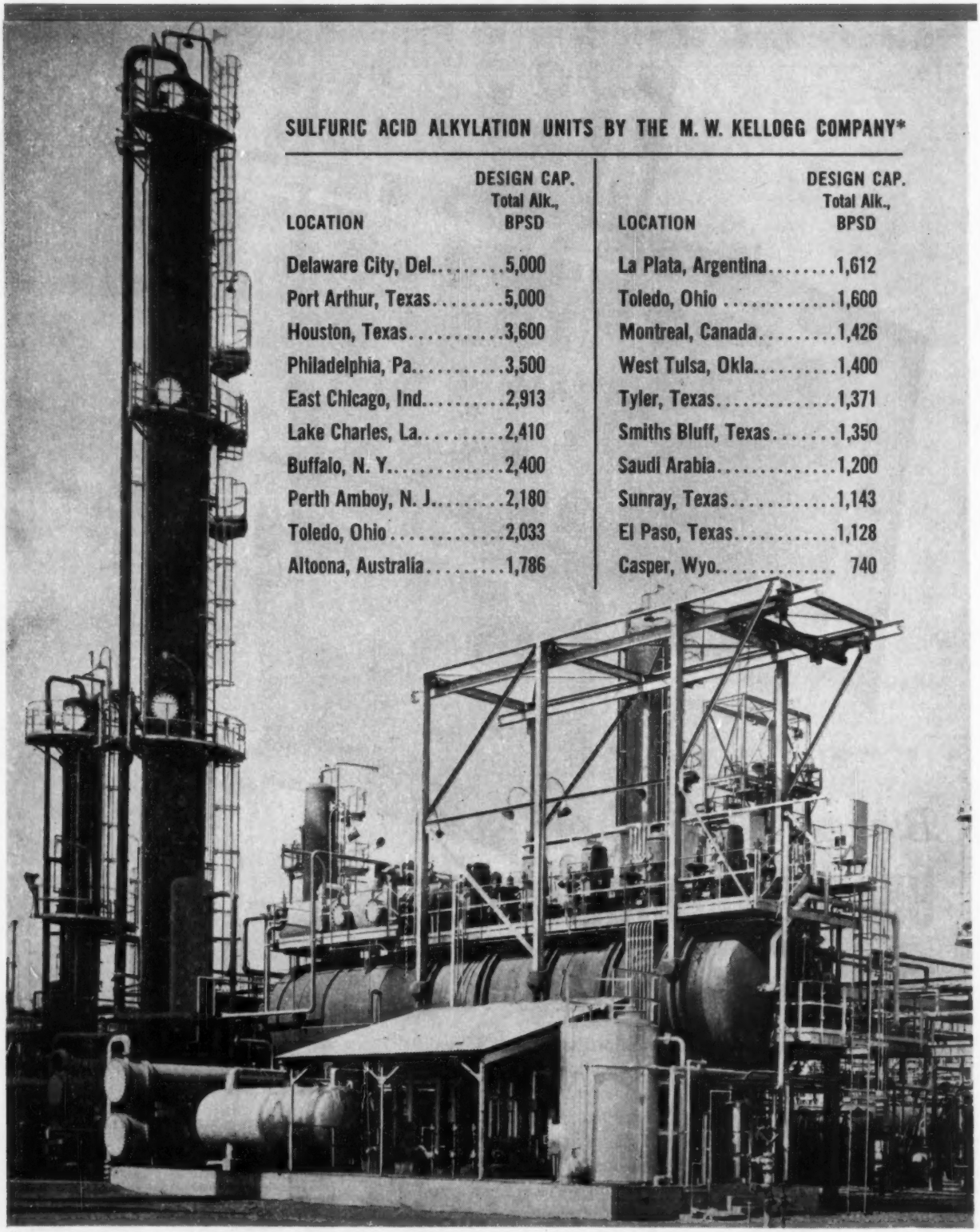
Today's Ultimate



SULFURIC ACID ALKYLATION UNITS BY THE M. W. KELLOGG COMPANY*

LOCATION	DESIGN CAP. Total Alk., BPSD	LOCATION	DESIGN CAP. Total Alk., BPSD
Delaware City, Del.	5,000	La Plata, Argentina	1,612
Port Arthur, Texas	5,000	Toledo, Ohio	1,600
Houston, Texas	3,600	Montreal, Canada	1,426
Philadelphia, Pa.	3,500	West Tulsa, Okla.	1,400
East Chicago, Ind.	2,913	Tyler, Texas	1,371
Lake Charles, La.	2,410	Smiths Bluff, Texas	1,350
Buffalo, N. Y.	2,400	Saudi Arabia	1,200
Perth Amboy, N. J.	2,180	Sunray, Texas	1,143
Toledo, Ohio	2,033	El Paso, Texas	1,128
Altoona, Australia	1,786	Casper, Wyo.	740

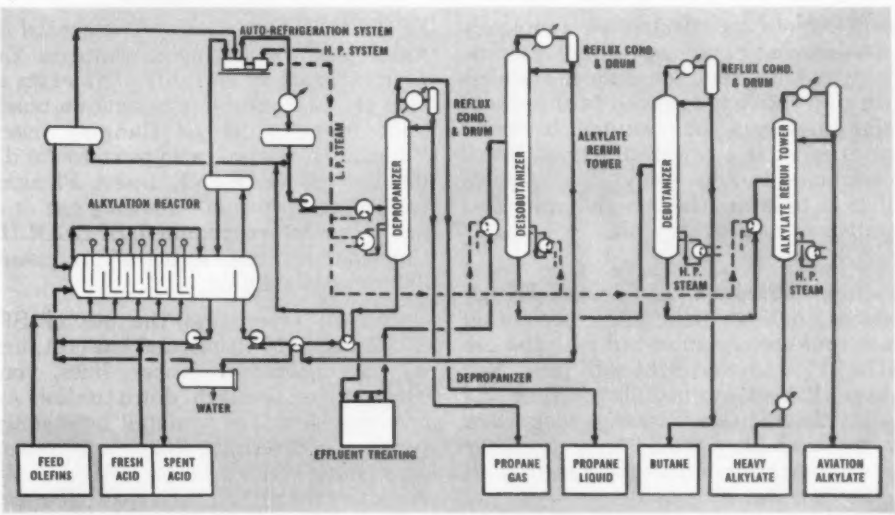
*List shows only units utilizing Kellogg's Cascade Reactor. Kellogg has also engineered and built many alkylation units of other types.

in ALKYLATE . . .

Measured by every standard . . . by quality and quantity of yield . . . by initial investment . . . by operating costs . . . M. W. Kellogg's sulfuric acid alkylation process is bringing optimum results to an increasing number of leading refiners both at home and abroad.

With its present advanced design, utilizing the company's unique multiple-stage cascade reactor and auto-refrigeration system, Kellogg alkylation offers the ultimate today in high isobutane efficiency, low acid consumption, low outlay for recycle and auxiliary equipment, and low utilities cost.

The M. W. Kellogg Company welcomes the opportunity to describe this alkylation process in detail, and to acquaint refiners with the improvements its engineers are continually making toward still greater economy and efficiency.



Refinery Process Division

The M. W. Kellogg Company

711 Third Avenue, New York 17, N.Y.

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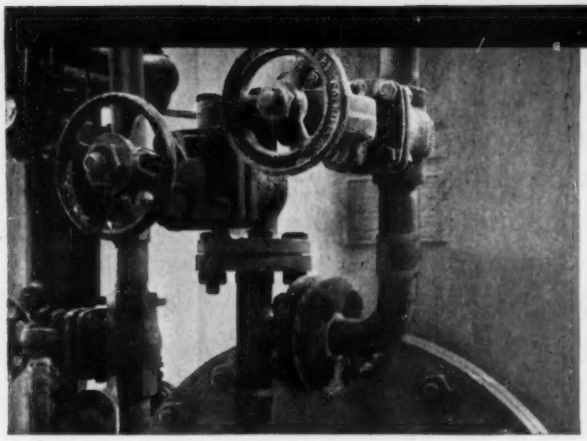
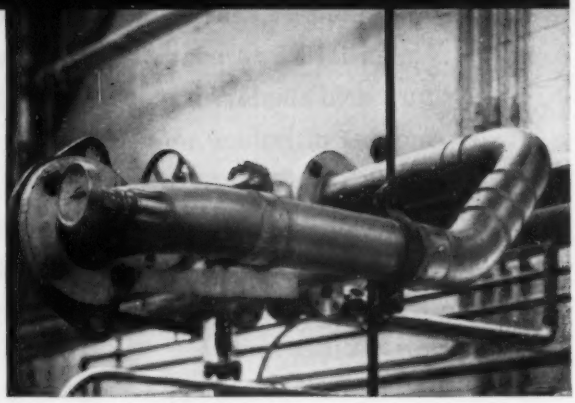
Speedline® FITTINGS CUT INSTALLATION TIME 70% AT KOPPERS®





70% Reduction in Installation Time

Plus Savings in Material Costs on Stainless Steel Process Lines

Manufacture of polyethylene demands a completely leak-proof, non-corrosive process piping system. Koppers Company knew that Schedule 40 stainless steel pipe with conventional threaded fittings could solve corrosion problems, but wanted to avoid costly leakage at joints in a new installation. "Back welding" to eliminate leakage would require additional installation time and labor—and result, at best, in a cumbersome, unsightly job.

So Koppers chose SPEEDLINE Fittings. Extensive tests proved to them that 100% protection against leakage could be accomplished with the use of SPEEDLINE Fittings and light wall pipe. Not only was leakage avoided, but installation time was reduced by 70%. In addition, material costs were considerably less than they would have been for pipe wall heavy enough to allow for loss of wall thickness at the threads.

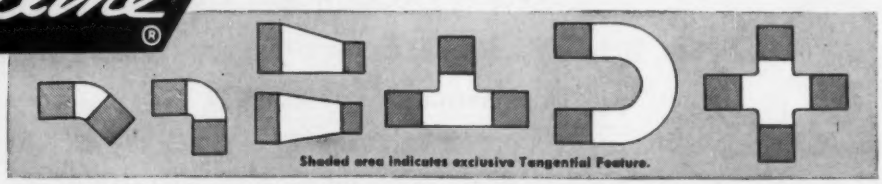
SPEEDLINE's exclusive "tangential feature" provides the engineering advantages that simplify process pipeline assembly. The extra straight section on all formed fittings allows maximum clearance for welding or flanging assembly. The "tangential feature" also provides for direct attachment of SPEEDLINE Insert Flanges by simple expanding operation—allowing use of flanged connections wherever required. SPEEDLINE Aligning Connectors permit "in place" pre-assembly of pipeline prior to welding.

Once you investigate the use of SPEEDLINE Stainless Steel Fittings and low cost, light wall pipe for your particular process lines, you'll discover bonus advantages right down the line. An illustrated brochure describes in detail how a SPEEDLINE system can determine efficient process operations at your plant. Write for a copy without obligation . . . or contact the SPEEDLINE distributor nearest you.

Speedline®

SPEEDLINE DISTRIBUTORS ARE LOCATED IN PRINCIPAL CITIES FROM COAST TO COAST

Write for a copy of "Speedline Fittings"... without obligation



Shaded area indicates exclusive Tangential Feature.

®REG. TM SPEEDLINE STAINLESS STEEL FITTINGS—*the newest thing in pipeline economy*

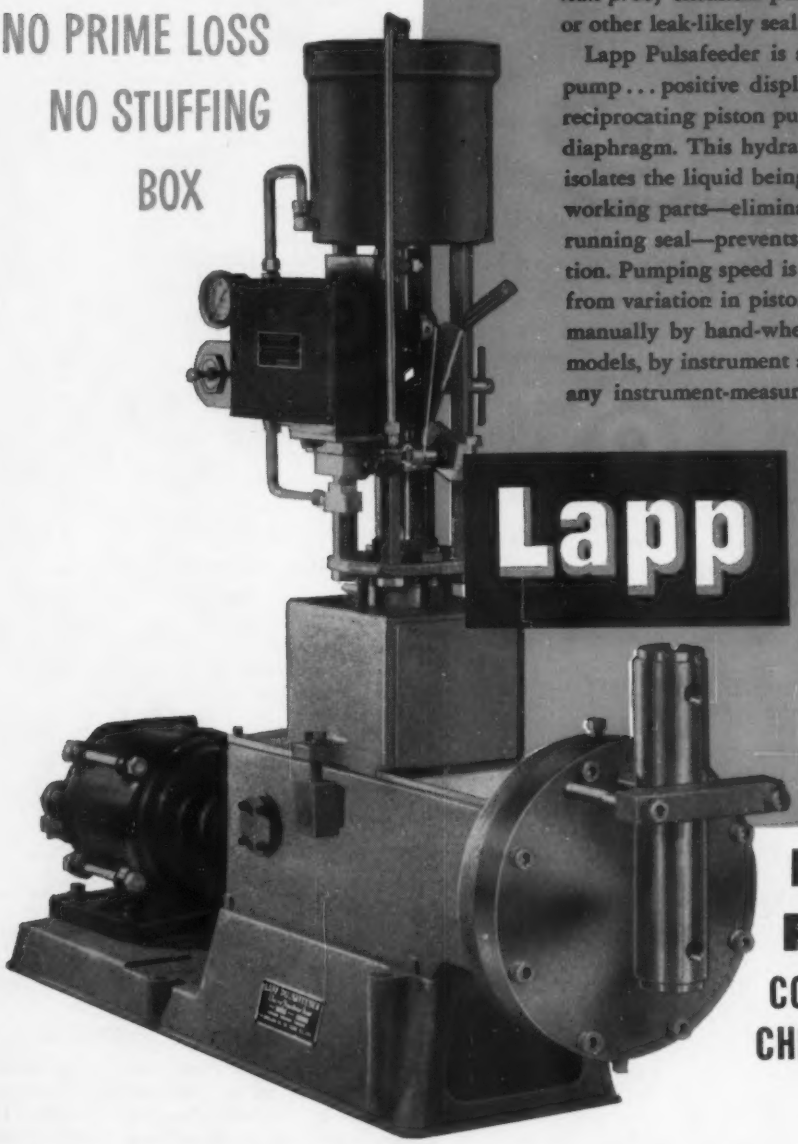
Manufactured by **HORACE T. POTTS COMPANY** • 566 E. Erie Avenue • Phila. 34, Penna.

Replace with PULSAFEEDER for Trouble-Free Liquid Metering

NO LEAKAGE
NO CONTAMINATION
NO PRIME LOSS
NO STUFFING BOX

When the time comes to replace the chemical pump in your process, replace with a PULSAFEEDER—the *leak-proof* chemical pump that has *no stuffing box* or other leak-likely seal.

Lapp Pulsafeeder is a combination piston-diaphragm pump . . . positive displacement is achieved by a reciprocating piston pumping a hydraulic oil against a diaphragm. This hydraulically balanced diaphragm isolates the liquid being pumped from the pump's working parts—eliminates need of stuffing box or running seal—prevents product leakage and contamination. Pumping speed is constant, variable flow results from variation in piston-stroke length . . . controlled manually by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable process variable.



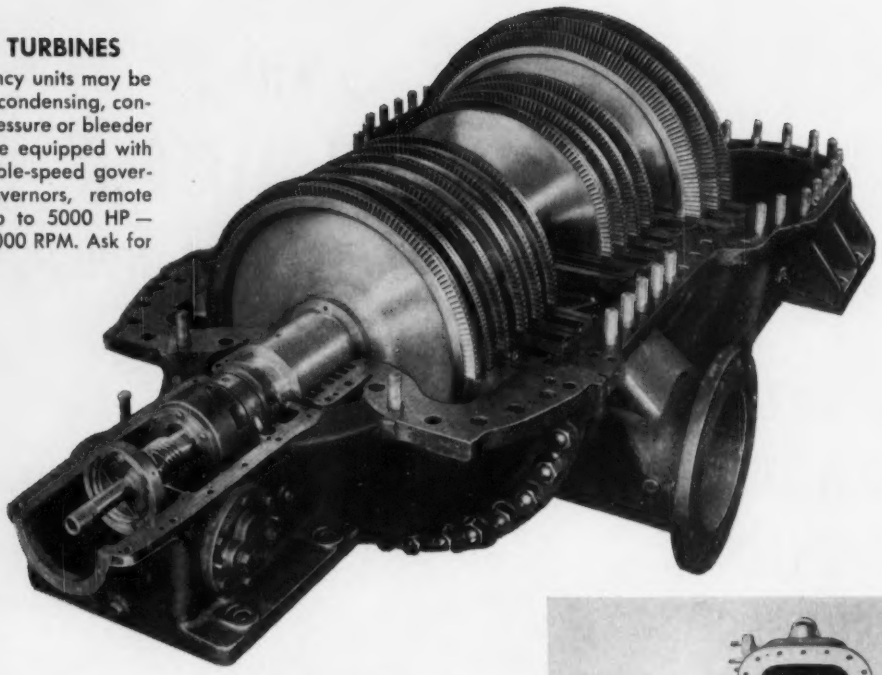
WRITE FOR BULLETIN 440
with typical applications, flow charts, description and specification of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Division, 539 Poplar Street, Le Roy, N. Y.

Lapp PULSAFEEDER
CONTROLLED-VOLUME CHEMICAL PUMP

For more data on advertised products, use Readers' Service Cards, last page.

MULTI-STAGE TURBINES

These high-efficiency units may be designed for non-condensing, condensing, mixed pressure or bleeder operation. Can be equipped with constant or variable-speed governors, special governors, remote controls. Sizes up to 5000 HP — Speeds up to 10,000 RPM. Ask for Bulletin S-146.



There's a **Terry turbine** for every mechanical-drive requirement

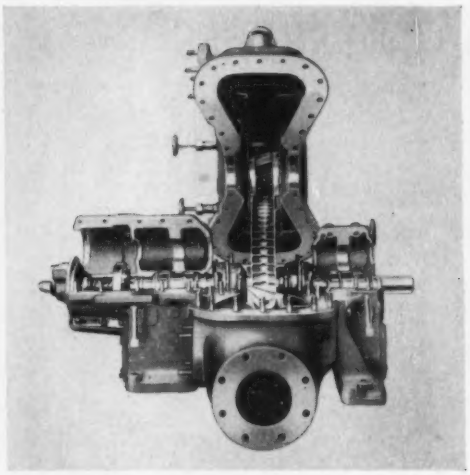
The designs for Terry turbines are based on more than 50 years of successful experience in the manufacture of turbine drives *exclusively*. This specialization has resulted in Terry becoming one of *the leading producers* of mechanical-drive turbines in sizes up to 5,000 horsepower.

There are three basic reasons why Terry has been able to maintain this position of leadership: (1) a thorough knowledge of the requirements of mechanical-drive turbines, (2) a willingness to build "a little something extra" into each machine to assure trouble-free operation, and (3) an acknowledgement of the company's responsibility to stand behind the performance of every turbine sold.

These are also the reasons why you should consider a Terry turbine for your next mechanical drive. In the meantime, send for bulletins describing any of the types of machines illustrated.

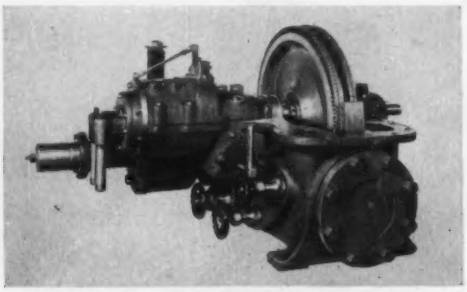
THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



SOLID-WHEEL TURBINES

Famous for sure dependability and ease of inspection. Can be started cold — no preliminary warming required. Available in vertical designs depending on frame size. Capacities from 5 to 2,000 HP. Described in Bulletin S-116.



AXIAL-FLOW IMPULSE TURBINES

Built with one, two or three rows of high-grade stainless steel blading, these turbines combine efficiency with durability. Available in designs for moderate and high steam pressure. Bulletin S-143.

TT-1209

The First HEXANE ISOMERIZATION

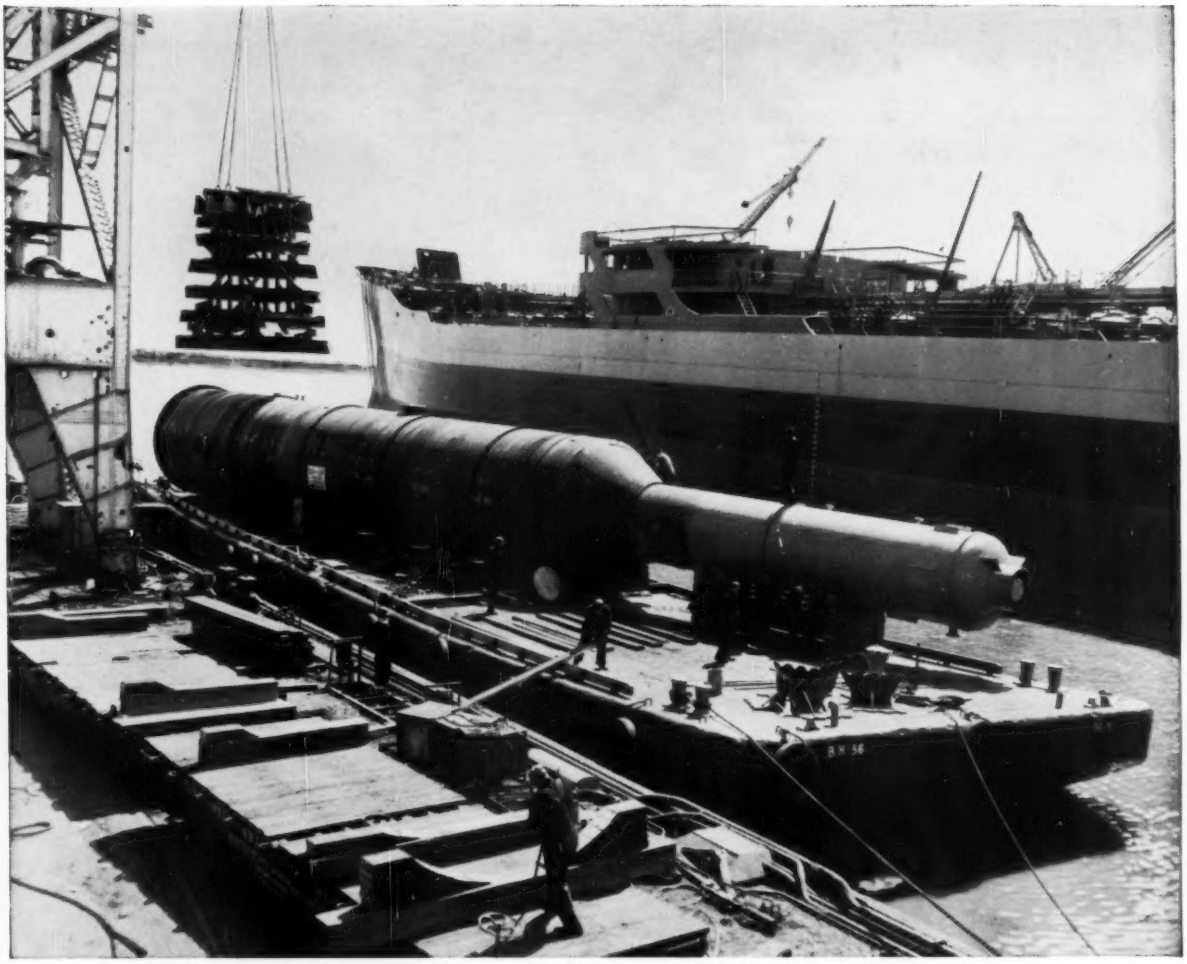
In a program to increase octanes of field distillate-derived motor fuels, Atlas Processing Company at Shreveport, Louisiana, has selected HUDSON to construct a normal hexane isomerization unit – the first contracted to be built. Low octane hexane will be fractionated from the total refinery feed stocks, and catalytically converted to high octane fractions to give substantial increase in octanes of finished gasolines.

Through 25 years of ever-changing process techniques HUDSON has served the refining and natural gas industries – completing major projects throughout the free world, and building the HUDSON reputation for experience, integrity and ability.

DESIGNERS AND CONSTRUCTORS OF PROCESS PLANTS FOR THE OIL, GAS, CHEMICAL, AND MINING INDUSTRIES

HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS



standard procedure: VERSATILITY...

The variety of work which Sun Ship's integrated shops produce for use by industries on land and sea brings a matching variety of shipping problems.

Our facilities for tidewater shipment are used to economical advantage on many of the massive structures that go into the making of the nation's petroleum and chemical industries. The barge shipment of tower and shed row baffles, shown above, is a good example.

And of course—when shipment by land is necessary—Sun Ship rigging and routing find the ways and means to handle such items as large-diameter columns by rail and truck.

It's all a part of the versatility which forty years' experience has made part of "standard procedure" in service of its customers.

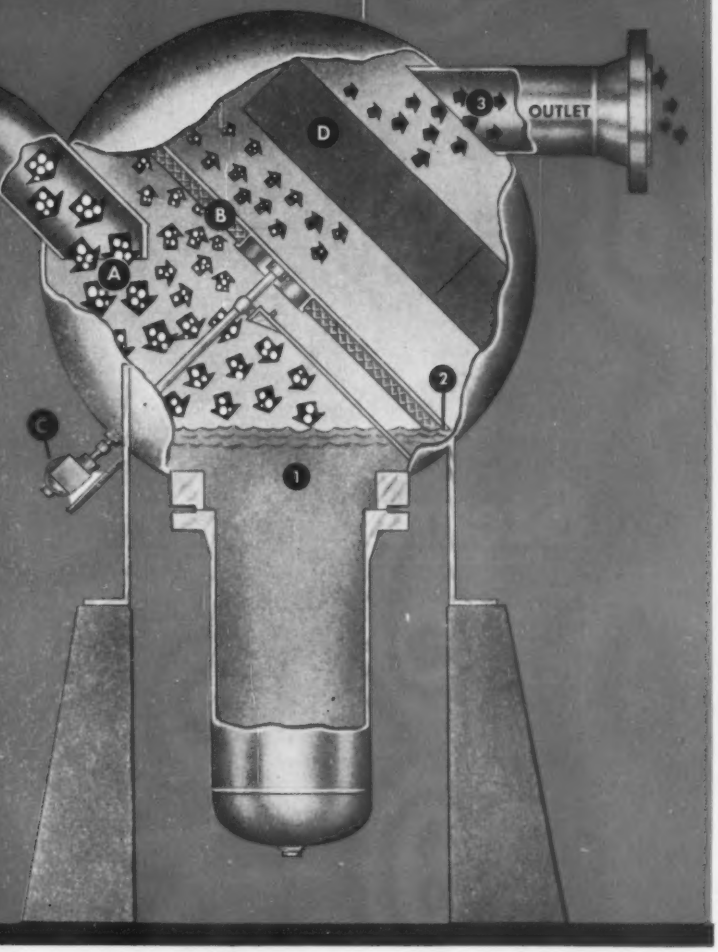
Our Sales Engineering Department would be glad to use its experience in helping you overcome any problem of construction or shipment that faces you. Write

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE SINCE 1916 **CHESTER, PA.**

SCRUBOSPHERE* ...



... FOR *Cleaner Gas* AT *Less Cost!*

*PEERLESS SPHERICAL
DUST and LIQUID SCRUBBER
FOR GAS PIPELINES

(A) The majority of incoming liquid and solid particles are directed down into reservoir. 1

(B) Lighter solid particles carried by gas stream are separated on surfaces of contactor which are kept wet and clean by revolving thru liquid reservoir. 2

(C) Contactor is revolved by explosion-proof gear motor.

(D) Mist Extractor removes any remaining liquid particles from gas stream prior to outlet. 3

- The **dust removal ability** of the SCRUBOSPHERE **is superior** because it utilizes wetted surfaces for dust collection which are much more closely spaced than in conventional equipment.
- **Oil loss is minimized** because the oil used to wet the dust collecting surface is lifted mechanically instead of bubbling gas through the oil which results in foaming and loss due to creation of hard-to-separate fine particles.
- **Maximum performance and low cost** - The spherical design means high capacity and performance because it provides maximum dimensions for the contactor and mist extractor which normally are limiting factors in scrubber designs. The vessel cost is reduced because required vessel thickness is only one half that required for cylindrical vessel of same diameter.
- **Versatility — separates solid and liquid particles with equal efficiency.**
- **Low pressure drop — ½ to ¾ psi at rated capacity depending on nozzle size.**

PEERLESS MFG. CO. DALLAS TEXAS

PEERLESS MANUFACTURING CO.

P. O. BOX 13165 DALLAS, TEXAS

Representatives in All Principal Cities

Write for test data showing dust removal and oil loss of Peerless Scrubosphere as against conventional dust scrubber.

In gas processing plant or compressor station design and construction, Stearns-Roger has both the experience and the ability that result in successfully operating turn-key jobs for the most discerning customer. When you lay your plans, take it up with

Stearns-Roger

THE STEARNS-ROGER MFG. CO. DENVER, COLORADO

ENGINEERS
CONSTRUCTORS
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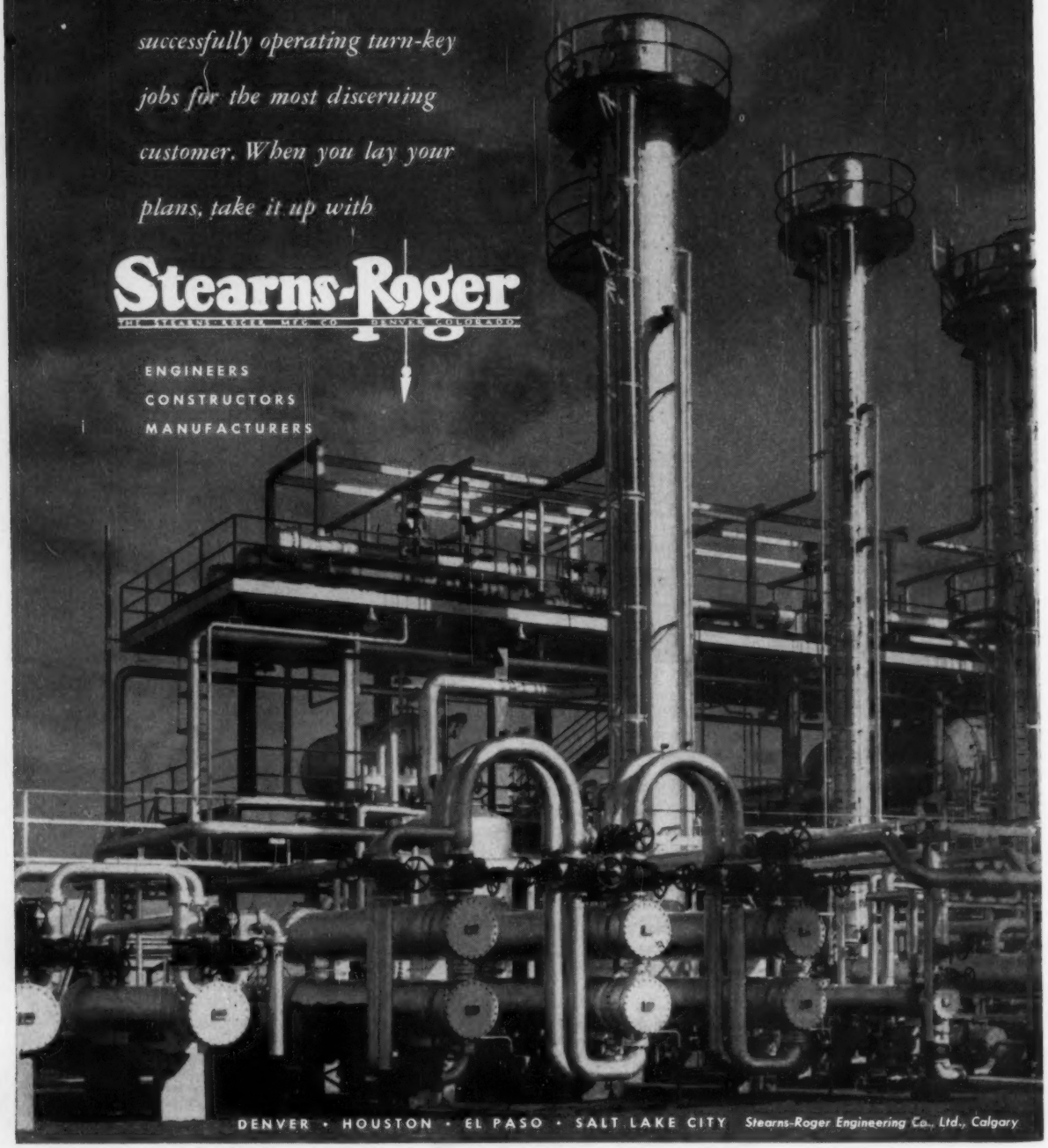

DENVER • HOUSTON • EL PASO • SALT LAKE CITY *Stearns-Roger Engineering Co., Ltd., Calgary*

New service for Organic Chemical users

For the specialized service required by consumers of organic chemicals, call Olin Mathieson. The Organic Chemicals Division now makes available a team of experts, ready to give you the technical assistance needed in the handling and use of this special group of chemicals.

Production is at Olin Mathieson's modern hydrocarbon plant in Brandenburg, Kentucky; local stock points are located in key industrial areas. For data sheets and shipping information, write today.

Ethylene Oxide · Ethylene Glycol · Diethylene Glycol Triethylene Glycol · Polyethylene Glycols (Poly-G's) Glycol Ether Solvents (Poly-Solv's) · Ethanolamines Surfactants (Poly-Tergents) · Ethylene Dichloride Dichloroethylether.

Poly-G®, Poly-Solv® and Poly-Tergent are trademarks

5514

MATHIESON **ORGANIC CHEMICALS DIVISION** OLIN MATHIESON CHEMICAL CORPORATION ONE PARK AVENUE, NEW YORK 16, NEW YORK

For more data on advertised products, use Readers' Service Cards, last page.

IT STICKS TO HOT OR COLD SURFACES!

EAGLE-PICHER

SUPER "66"

INSULATING CEMENT

SPOTTING! TROWELLING! FINISHING!

- Because it sticks, Super "66" saves time—applies quickly to any equipment, cold or hot! Effective up to 1800 F.
- Because it sticks, Super "66" saves money—provides far greater coverage and more efficient insulation.
- Because it sticks, Super "66" makes difficult jobs easy—can be used on irregular shapes where application of other insulations is often impossible. Usually requires no reinforcing on applications up to 1½ inches thick.
- Unique "springy ball" structure of small, resilient mineral wool pellets results in maximum efficiency—maximum fuel savings!
- Super "66" contains a special rust inhibitive which actually prevents corrosion!

Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.

FREE SAMPLE!

Write today!

Eagle-Picher Super "66" Insulating Cement conforms to Commercial Standard CS-117-49.

Since 1843

EAGLE PICHER

EAGLE-PICHER

The Eagle-Picher Company • General Offices: Cincinnati 1, Ohio

(*Member of Industrial Mineral Fiber Institute*)

HOW GOOD IS YOUR KNOWLEDGE OF BF_3?

See whether you can match up the processes "carried through" by this versatile and efficient catalyst with the various products of these reactions. If you need additional information, mail the coupon below.

Phenol Alkylates

Non-Ionic Detergents

Synthetic Rubber

Plastics

Resins

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Solvents

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POLYMERIZATION
ALKYLATION
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ARYLATION
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HYDRATION
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NITRATION
SULFONATION
HALOGENATION

(There are more!)

BAKER & ADAMSON offers Boron Trifluoride gas and a wide range of Boron Trifluoride complexes. These catalysts offer many important advantages to the chemical engineer and process designer. Generally speaking, you gain these benefits:

- Wider operating temperature ranges
- Increased yields
- Easier separations with no bulky sludges
- Improved properties of end products
- More reactions carried to completion
- Fewer undesirable waste materials
- Greater catalytic activity from smaller quantities
- More easily controlled reactions

75 YEARS OF LEADERSHIP IN CHEMICAL PURITY

For detailed information, mail coupon today

BAKER & ADAMSON® *Fine Chemicals*
GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

☐ Please send general information on properties and uses of Boron Trifluoride gas ( ), _____ complex ( ).

☐ Please send information on Boron Trifluoride for the following application:

_____

Name _____

Position _____

Company _____

Address _____

City _____ Zone _____ State _____

PR-11

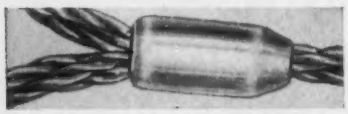
For more data on advertised products, use Readers' Service Cards, last page.

Only 2 Pounds of Tuffy Sling Per Ton of Load

The slings hoisting this hydraulic press are 1¼" Tuffy U-1s. For each 2 pounds of their own weight, two Tuffy U-1s of this length (basket hitch) are rated to handle a ton of load. Pound for pound Tuffys are weight lifters extraordinary.

The secret of the amazing strength of all Tuffy Slings is in the special purpose steel we use, and the way its wire fabric is machine-braided to give a combination of toughness and flexibility you won't find in any other machine made sling.

Tuffy Slings are so flexible that kinks can be pounded out easily without sling damage. And it's mighty hard to kink a Tuffy Sling in the first place. Tuffy's resistance to knotting, kinking and looping is just one reason why Tuffy Slings have an enviable record of giving longer service life than ordinary slings. For another reason, look at the Tuffy ferrule...



Tuffy's pressed-on ferrule gives the tucked eye splice 100% of fabric strength. Applied under great pressure, the steel ferrule literally flows into every space between the wires and strands, developing friction force equal to fabric strength. Another reason why you can't match Tuffy for taking deadloads, shocks and impacts!

Your Tuffy Distributor is Stocked to Meet Your Needs

He'll help you save money with the longer trouble-free service life of Tuffy Slings. He's ready with your Tuffy Slings and Union Wire Rope needs. Get in touch with him now!

FREE— Get Your Tuffy Sling Handbook

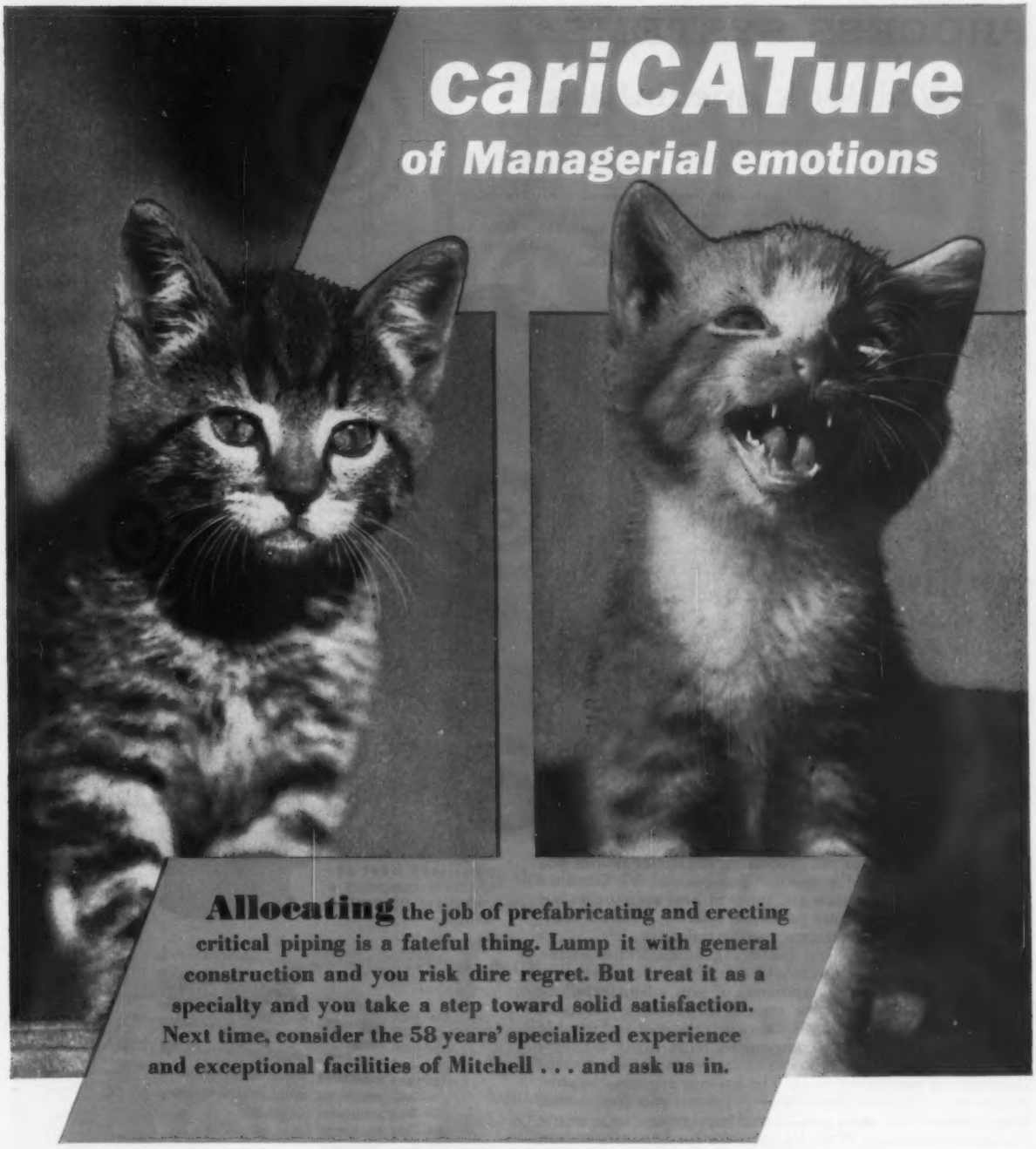
Gives complete data on Tuffy Sling types, dimensions, weights and rated loads. Plus a complete rigger's manual and engineer's notebook on wire rope constructions and specifications. Write us for your copy!

union Wire Rope corp.

2284 Manchester Avenue, Kansas City 26, Mo.

Specialists in high carbon wire, wire rope, braided wire fabric, stress relieved wire and strand

(25)



Allocating the job of prefabricating and erecting critical piping is a fateful thing. Lump it with general construction and you risk dire regret. But treat it as a specialty and you take a step toward solid satisfaction. Next time, consider the 58 years' specialized experience and exceptional facilities of Mitchell . . . and ask us in.

W. K. MITCHELL & CO., INC.

Philadelphia 46, Pa.

WESTPORT JOINT
(PATENTED)

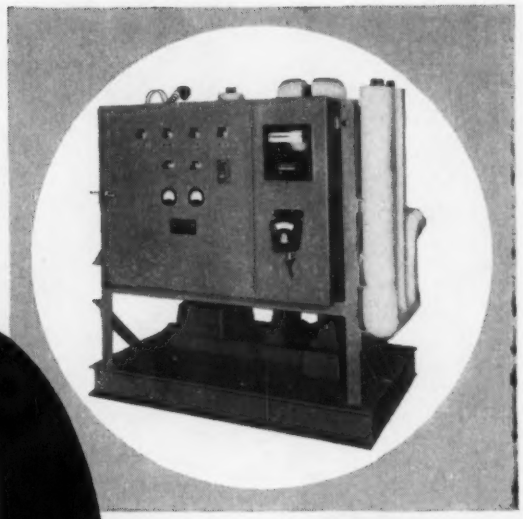
MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS

For more data on advertised products, use Readers' Service Cards, last page.

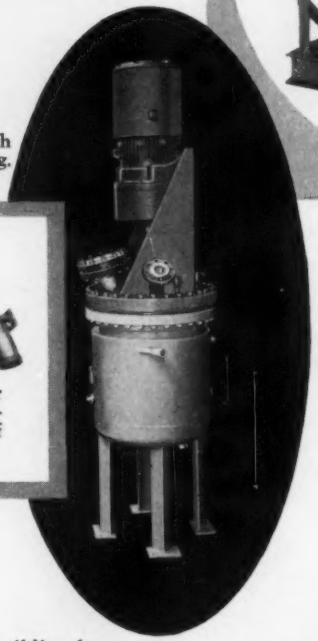
PROCESS SYSTEMS

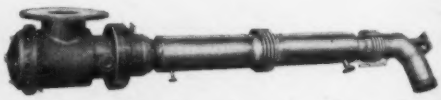
. . . Whitlock Specialties



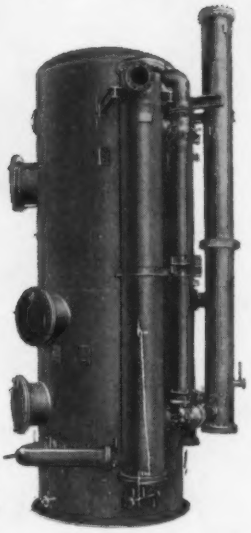
Transfer Oil Heating System, complete unit ready to install. Temperature controls maintain the oil supply temperature within ± 2° F. Available in Standard, or Group 1 Class D Explosion-proof Constructions.

Jacketed Kettle complete with agitator for grease processing.





Secondary Gas Precooler used with reactor in chromium ore plant. Two corrugated expansion joints accommodate expansion of parts due to elevated temperatures.

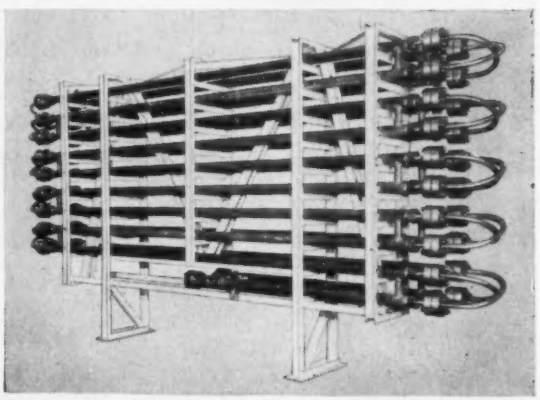


Large Converter with auxiliary heat exchangers comprises a complete operating unit.

Whitlock's long experience in designing and building heat transfer equipment for the processing industries assures you the most satisfactory "in-service" equipment. We fabricate not only the standard sizes and types of heat exchangers but engineer and manufacture packaged systems, with all operating components, to perform specific tasks.

Send us your flow sheets specifying fluids, temperatures, and pressures. Our engineers will design the equipment you need. We'll supply all components, if you wish, including exchangers, tanks, pressure vessels, condensers, columns, reboilers, coils and piping. We save you the cost and trouble of obtaining the various components from many different sources and our extensive stocks of materials permit prompt shipment of your equipment. The savings are considerable, of course . . . in time and money . . . when you concentrate responsibility for your engineered equipment in a single competent producer. Write us today for further information and recommendations.

THE WHITLOCK MANUFACTURING COMPANY
75 South Street, West Hartford 10, Connecticut
In Canada: Darling Bros., Ltd., Montreal

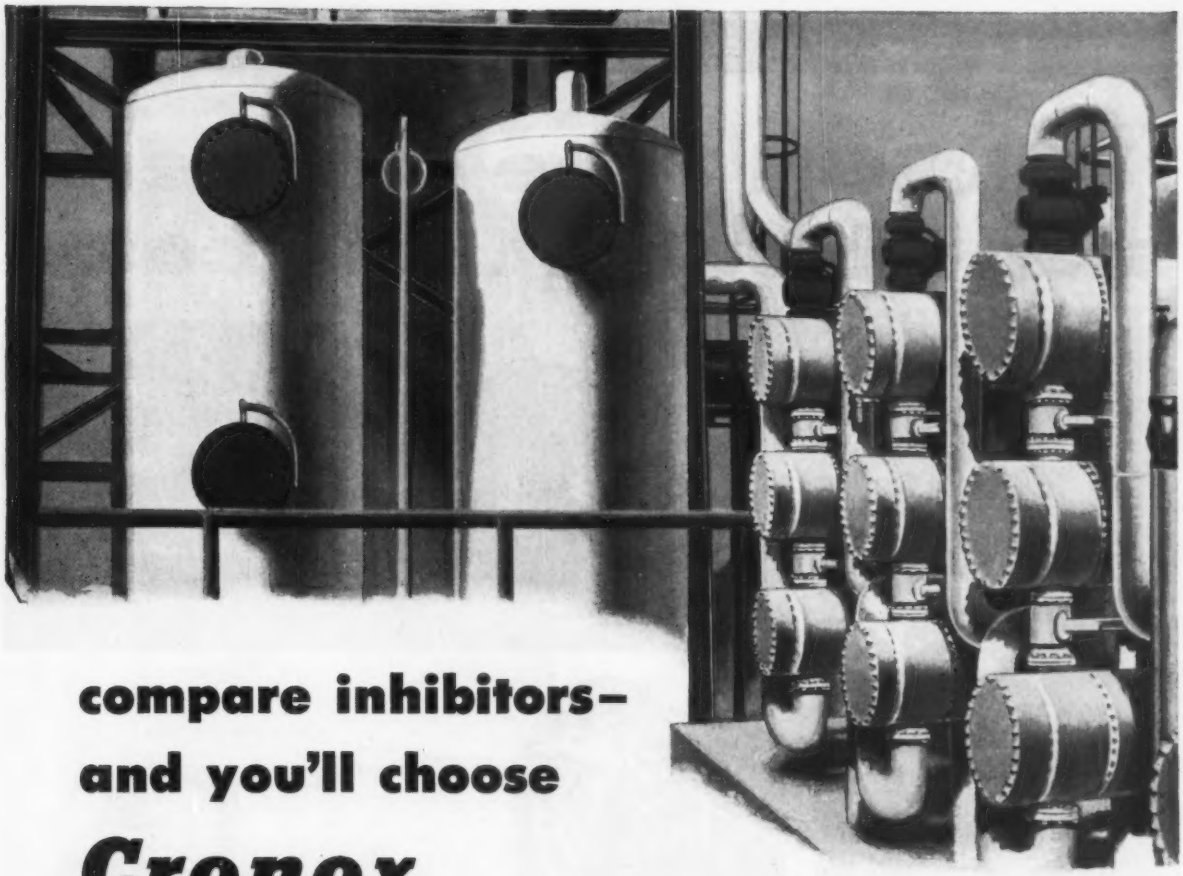


Primary Aftercooler removes heat generated in compressing ethylene gas.

Be sure to visit Booth 1181 at the Chem Show

Whitlock

Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers



compare inhibitors– and you'll choose *Cronox*

How long has it been since you gave your refinery corrosion protection program a thorough evaluation? Unless you're using the latest in inhibitors, you may be missing the chance to get the big savings that modern protection can give you.

Compare CRONOX inhibitors for *effectiveness*. You'll find that they produce a film which controls pitting, fouling and blistering.

Compare them for *economy*. Injection rates of 6 to 9 ppm give lasting protection in most applications.

Call Aquaness today, for a consultation on your specific corrosion problems, and for a recommendation of the most effective Aquaness inhibitor from our versatile line.

Aquaness *Department*
ATLAS POWDER COMPANY
2005 Quitman Street, Houston 26, Texas

Chemicals for Refining, Gasoline Plants and Oil Transportation

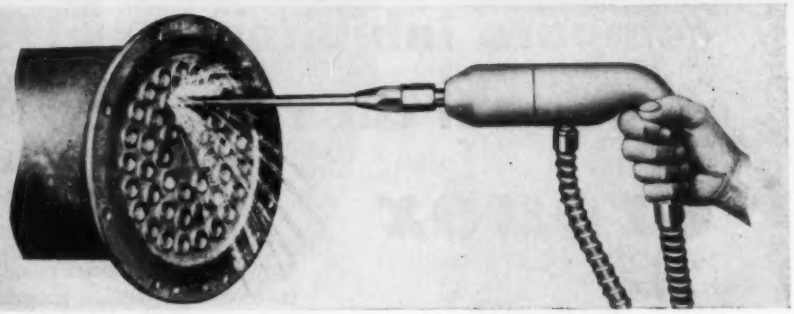
For more data on advertised products, use Readers' Service Cards, last page.

Two FAST ways to clean fouled heat exchanger tubes

WILSON Tube Cleaners step up output...cut costs

WILSON Model TP-301 Cleaner in use

WILSON Model PGX Cleaner in use



These two Wilson high speed tube cleaners are designed to meet today's high production needs. They help step-up profits by cleaning fouled heat exchanger tubes rapidly, thus increasing output and minimizing downtime.

The powerful Wilson TP-301 tube cleaner is a positive air driven, rotary shaft, drill type tool. It is suitable for vertical or horizontal use in tube ⅜′ O.D. to 2⅞″ O.D. and up to 40 feet in length. Operating speed is up to 3,500 rpm at 90 psi utilizing 130 cfm. The Wilson TP-301 will quickly clean such deposits as calcium, carbonates, sulfates, sulphites, silicates, chlorides, and many other types of organic matter. Tube is scavenged with air or water while cleaning. No preliminary arrangements are necessary. Equipment goes back on stream rapidly.

Wilson also offers the Model PG tube cleaner for tubes from ¼″ to 1″ ID. This versatile light-weight tube cleaner weighs only three pounds... requires maximum of 35 cfm at 90 psi.

PGX TUBE CLEANER

The Wilson PGX tube cleaner is also a positive drive (not geared down) high speed, hollow rotary shaft, air-driven scavenger type cleaner. It washes out the tube and debris while it cleans and, at the same time, keeps the drill bit cool. There's no worry about jammed, burned out bits.

Designed for intermediate size tubes from ½″ to 1½″ ID, the Wilson Model PGX obtains maximum power at 90 psi using 75 cfm. It's suitable for horizontal or vertical applications ... requires only one man to operate.

• • •

Use these Wilson cleaners for: gas coolers, sulfite evaporators, glycerine evaporators, fuel oil heaters, polymerization units, humidifier tubes, tar heaters, water heaters, crude column heaters, small transfer lines, as well as miscellaneous heaters, condensers and evaporators.

TW-675

Representatives in principal cities

THOMAS C. WILSON, INC. • 21-11 44th Ave., Long Island City 1, N. Y.

Cable address: "Tubeclean", New York

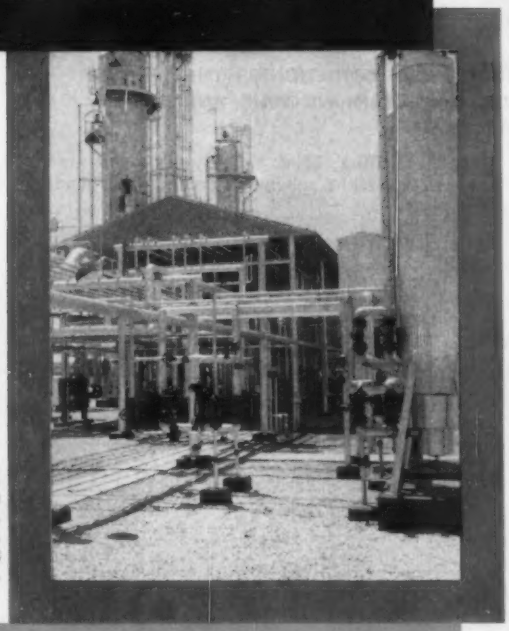
WILSON

TUBE CLEANERS • TUBE EXPANDERS

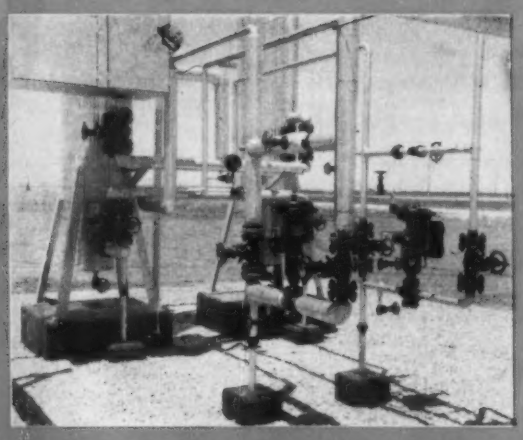
Write today for your copies of Wilson Tube Cleaner catalog No. 77 and Wilson Tube Expander Catalog No. 88.

start using orbit

forged steel asa class valves in your process area from formation to finished product



ight foreground, propane dehydrators. In background, plant process pump area.



ORBIT FORGED STEEL ASA CLASS VALVES IN SERVICE AT A KANSAS GASOLINE PLANT.

Propane dehydrators.

Product loadout pumps and storage area.

advantages

No voids or cavities in body or bonnet where pressures can build up from trapped fluids when valve is either in open or closed position.

Non-lubricated, positive, friction-free closure which eliminates possibility of product contamination from valve lubricants.

Rising stem.

Adjustable, pliable stem packing.

All forged steel, vapor-tight construction.

ORBIT ASA CLASS VALVES are available in Carbon or Stainless Trim. Full Round Opening Sizes 1" thru 4". Ratings: 300 lbs. thru 2500 lbs. Flanged or Screw Ends. Venturi Opening Sizes 2" thru 6". Ratings: 150 lbs. thru 2500 lbs. Flanged End Only.

AVAILABLE THRU YOUR FAVORITE OIL FIELD SUPPLY STORE OR REFINERY SUPPLY HOUSE

ORBIT VALVES®

ORBIT VALVE COMPANY

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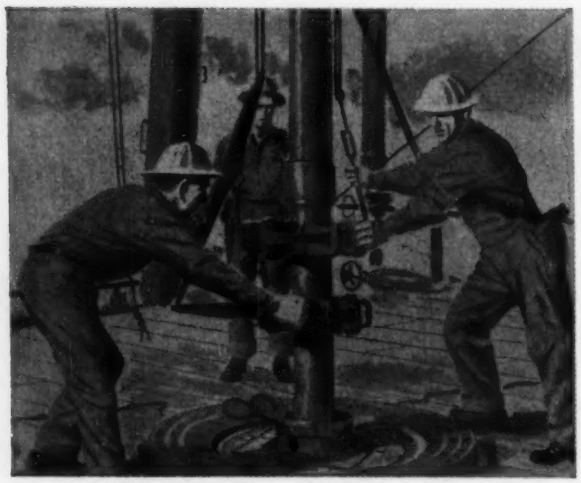
WEST COAST REPRESENTATIVE: Fred P. Koenig Company, Long Beach, Calif., 3815 Atlantic Avenue, GArfield 4-3834

CANADIAN REPRESENTATIVE: T. R. Pickford & Company, Ltd., Calgary, Alberta, 536 8th Avenue West, Phone 2-7371

EXPORT REPRESENTATIVE: New York 36, N. Y., 500 Fifth Avenue, BRyant 9-2236

Toward Deeper Drilling...More



RUGGED MUD CONDITIONERS THAT BENEFIT FROM NEW CYANAMID RESIN AND POLYMER DEVELOPMENTS

CYPAN® Drilling Mud Conditioner . . . a high molecular weight acrylic polymer for dependable water loss control.

PROVED HIGH-PERFORMANCE CATALYSTS THAT ARE PRETESTED IN OPERATING REFINERIES

Cracking

AEROCAT® Fluid Cracking Catalysts . . . microspheroidal catalysts, both 13% and 25% alumina types, available in several ranges of particle size distribution.

Reforming

AEROFORM® PHF Platinum Reforming Catalysts . . . platinum promoted alumina base

AEROFORM® MS-1 Fluid Hydroforming Catalysts . . . a spray-dried microspheroidal molybdena-alumina.

Desulfurization

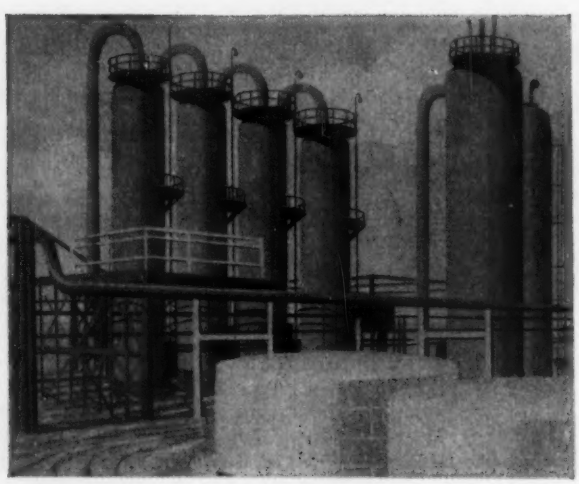
AERO* HDS Catalyst . . . an extruded cobalt-molybdena for sulfur and nitrogen reduction in conjunction with hydrogenation.

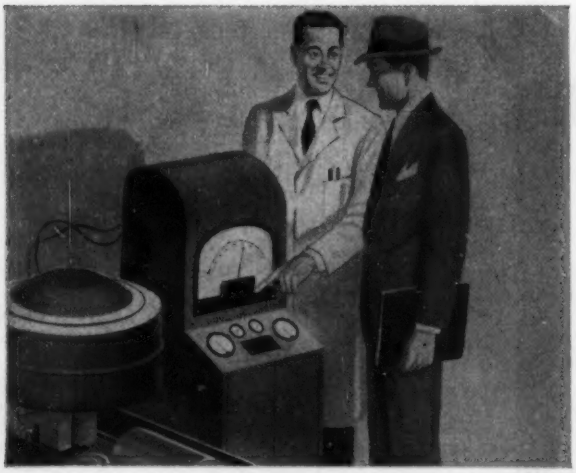
Ammonia and Hydrogen Production

AERO* Catalyst FM-2 for ammonia synthesis reaction.

AERO* Catalyst HI-3 for water-gas shift reaction.

AERO* Catalyst NR-1 and NR-2 for reforming methane, ethane or natural gas.





STABLE, HARD-WORKING ANTIOXIDANTS AND LUBE ADDITIVES THAT GIVE NEW LIFE SPANS TO FUELS, MOTOR OILS

AEROLUBE® Lubricating Oil Additives . . . in a wide formulation range for inhibitor-detergency action in all types of crankcase oils.

AEROLUBE® 93-C . . . a concentrated zinc dithiophosphate inhibitor with superior anti-wear characteristics.

AERONOX* Antioxidant 153 and 9010 . . . hindered phenol type for oils, greases and fuels.

AERONOX* MB Methane Base Antioxidant Inhibitor . . . an antioxidant and metal deactivator for special lubricants.

*Trademark

Efficient Refining...Better Oil Products

CYANAMID

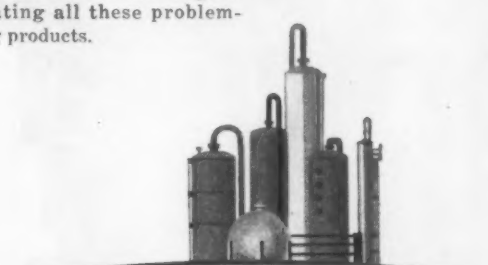
teams with the petroleum industry in developing better products

The practical experience of oilmen is part of every catalyst, mud conditioner, antioxidant and additive offered by Cyanamid. Practical product development has stemmed from a working partnership between Cyanamid and petroleum engineers – a sound basis for re-evaluating established products and testing new ones. Result: new and improved products second to none in performance.

Creative research, coupled with volume production, exacting quality control and fast, anxious-to-help technical service, has featured Cyanamid's 50 years of growth as a chemical manufacturer. This product dependability has been serving the petroleum industry for two decades – and can be working for *you*

PRODUCT IMPROVEMENTS ARE SPURRED BY CYANAMID'S BROAD, CONTINUOUS RESEARCH

Your product requirements—and the problems of the petroleum industry—are the concern of many skilled, creative laboratory teams at the Stamford Research Laboratories. Basic information is obtained by outstanding research specialists using a full range of modern analytical and testing equipment. Actual operating refinery tests are the final stage in evaluating all these problem-solving products.

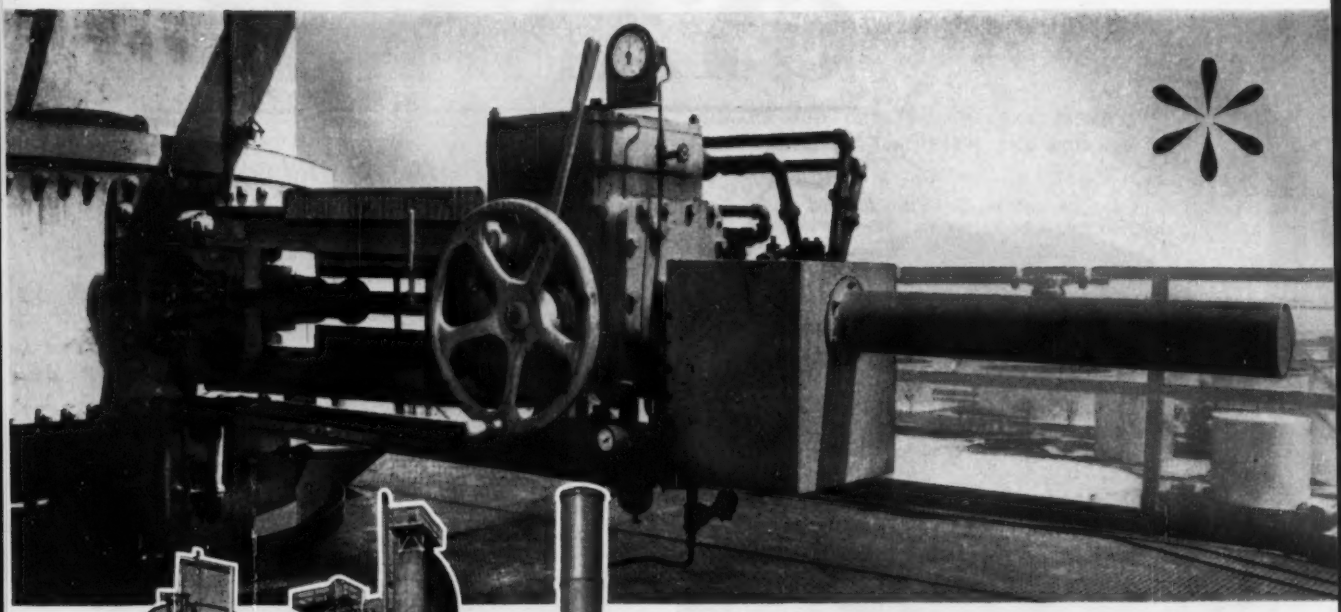


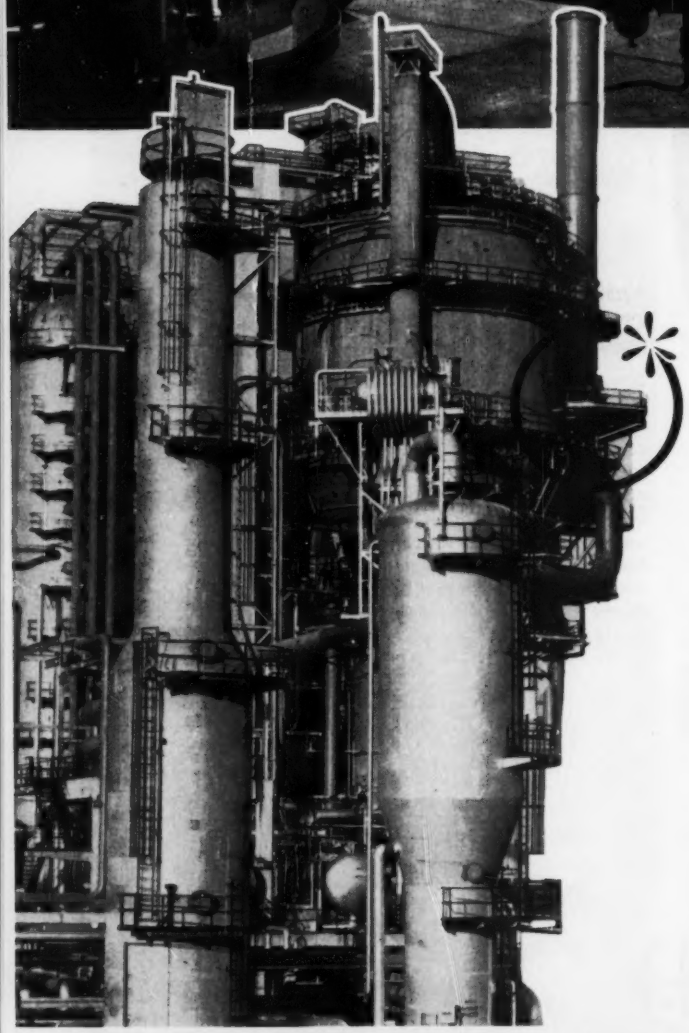
AMERICAN CYANAMID COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

CONOFLOW ROTOMOTORS®

CONTROL STACK VALVES IN WORLD'S MOST MODERN REFINERY





Throughout the world, hundreds of Conoflow Rotomotors are in constant use actuating large stack valves and slide valves. Rotomotors have proved to be the safest, most powerful, and most dependable actuators available for these critical throttling control services.

Seventeen Rotomotors were specified and installed by contractors in Tidewater's new Delaware Refinery—the world's largest integrated refinery.

Photographs show one of a pair of these unique pneumatic actuators operating a 72-inch double disc regenerator vent valve on a large diameter stack, 200 feet above ground on M. W. Kellogg Company's Orthoflow unit. The two Rotomotors actuate opposed sliding valve discs, each covering one-half of the rectangular port opening, 38 inches by 50 inches. Discs travel 25 inches from fully closed to fully opened position. Required positioning accuracy of one part in 400 of stem travel is obtained despite heavy stem load of 18,000 lbs. Assembly is completely air operated, hence explosion-proof.

How the Rotomotor Works . . .

is described with schematic diagrams in Conoflow Technical Bulletin 107-2, available on request. Send for your copy today—it will be mailed promptly.

Conoflow engineers, highly experienced in the application of the Rotomotor, will be pleased to assist you in determining its suitability for your requirements. Write today to Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Pa. Representatives in principal cities.

Cono-Controls®

CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

SUBSIDIARY OF WALWORTH

What's your tubing problem?

corrosion?
damage?
installation?
fire? cost?

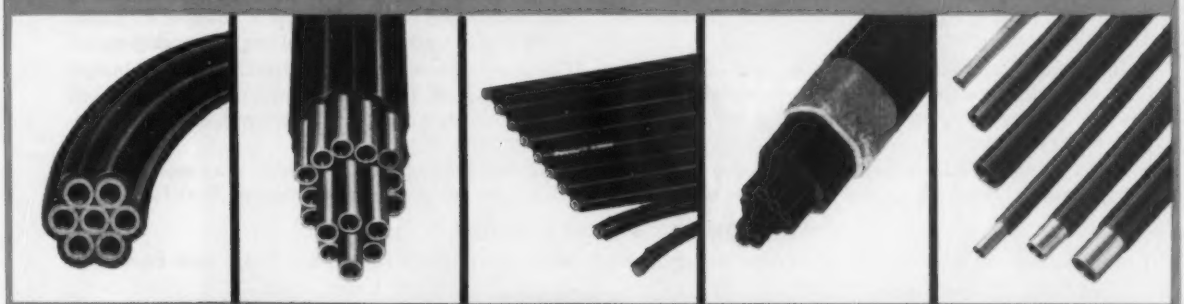
Wherever instrument tubing is used—be it refinery, natural gasoline plant, chemical, nuclear or food processing—Dekoron Tubing Products can help whip your ultimate twin problems of *maintenance-replacement expense and installation costs.*

Why?

First, because Dekoron Tubing products resist chemical attack and corrosion caused by moisture and industrial atmospheres. That means that once installed, Dekoron products are in to stay. You're not faced by perennial replacement and maintenance costs.

Second, the big savings in cost are yours in installation when you specify multiple-line Dekoron products—you install many instrument lines at once.

So if you have an instrument tubing problem of *any sort*, we probably have the answer *in stock*. If not, we can design and make it for you.



POLY-COR
From 2 up to 37 plastic tubes in plastic armor.

METL-COR
From 2 up to 19 copper or aluminum tubes in plastic armor.

RIBBON
M-Ribbon (metal) and P-Ribbon (plastic). 10 tubes in plastic sheath.

PROTECTO-PAC
Fire and impact resistant. Plastic tubes covered with plastic-asbestos-plastic armor.

SINGLE-LINE
Single steel, copper or aluminum tubes in plastic armor, or all-plastic tubing.

Dekoron® products
QUALITY • RESEARCH • SERVICE

SAMUEL MOORE & CO.
Dekoron Products Division
MANTUA, OHIO

For more data on advertised products, use Readers' Service Cards, last page.

For ACCURATE TANK GAUGING Get Wheaton *precision* in TANK GAUGES

Wheaton T-1600 Automatic Tank Gauge

This new Wheaton T-1600 Tank Gauge—developed and designed by Wheaton engineers—meets the most exacting requirements for *accuracy*. And it attains accurate gauging with a minimum of maintenance and wear.

The *large area* of the float assures the highest degree of sensitivity, and the use of 300 series stainless steel shafts and custom-fitted teflon bearings reduces friction to a minimum.

An exclusive "H" float affords easy fastening to guide wires without requiring special float guides or fasteners. The gauge can be read from the ground, obviating the need to climb the tank, and high visibility is assured by an easily-read, stainless steel tape, calibrated in feet, inches and eighths. The unit is powered by a specially engineered stainless steel neg'ator spring motor.

For maximum accuracy in tank gauging, install Wheaton T-1600 Gauges. They can be used on all types of tanks, including underground, and for all low-pressure storage.

Send for catalog No. 66, which illustrates and describes the complete line of Wheaton Tank Fittings.

WHEATON BRASS WORKS, UNION, N. J.

Manufacturers of Loading Arm Assemblies, Swing Joints, Loading Valves, Tank Fittings and Truck Tank Equipment

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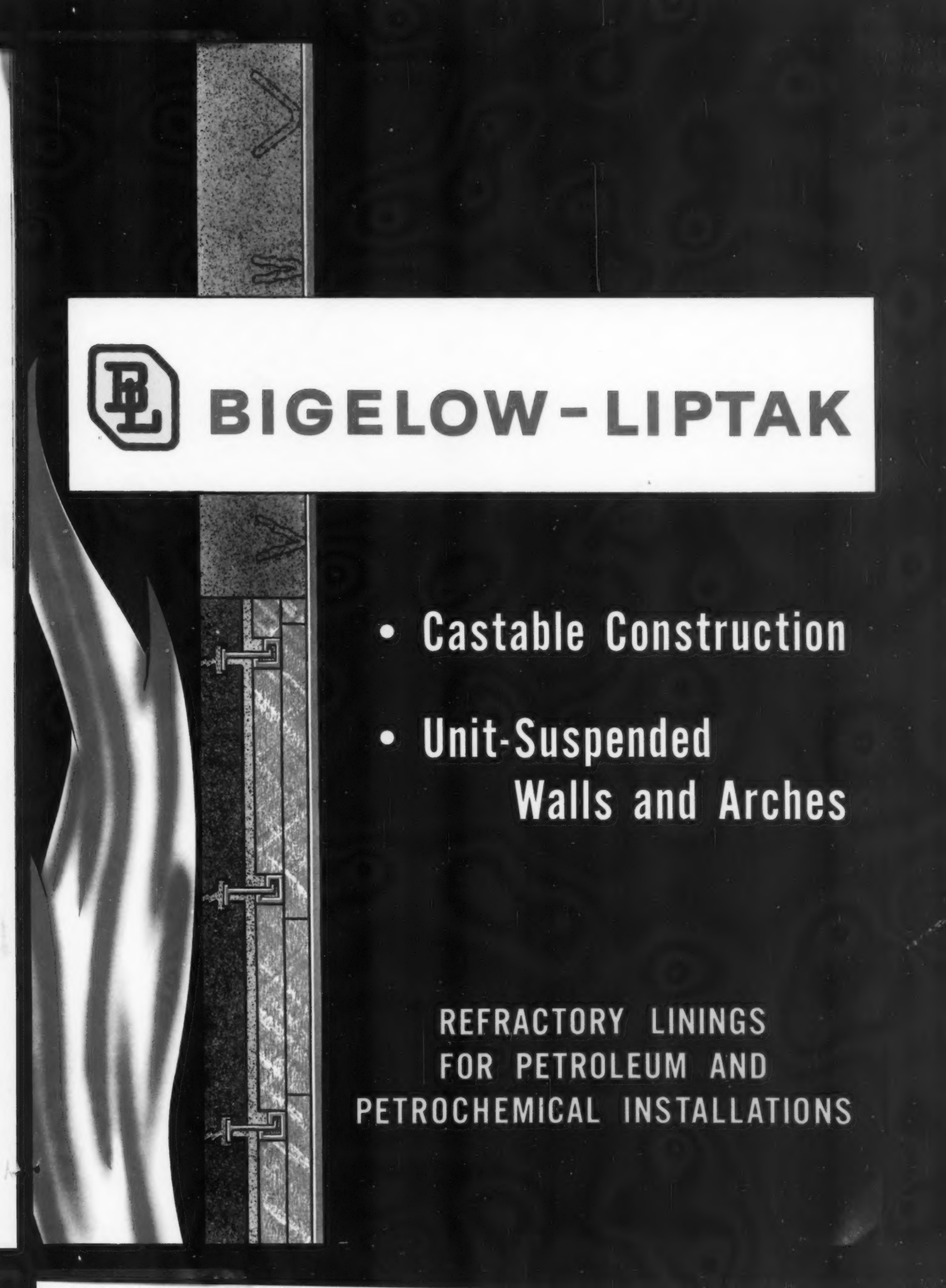
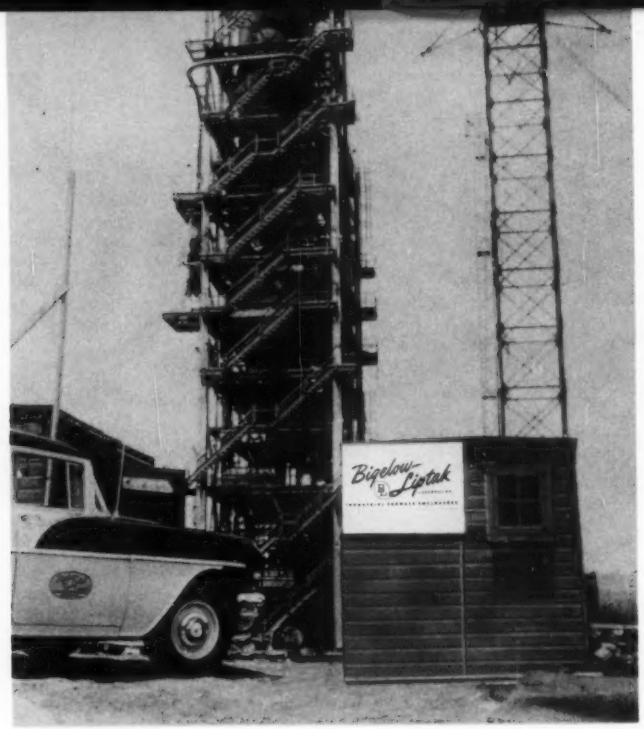
Tank Fittings by Wheaton

the best by every standard


BIGELOW-LIPTAK
• Castable Construction
• Unit-Suspended
Walls and Arches
REFRACTORY LININGS
FOR PETROLEUM AND
PETROCHEMICAL INSTALLATIONS



Three important services for castable users

ENGINEERING

MATERIALS

ERECTION

Oil refineries and processing companies today have a single coordinated source for the three elements of a vessel lining or a heat enclosure job. This represents a proven Bigelow-Liptak service including high-level engineering, job-tested materials and complete erection.

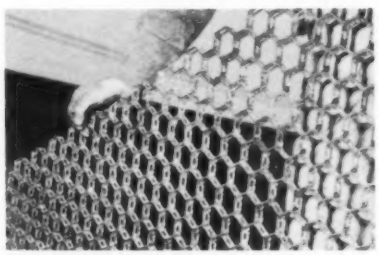
Bigelow-Liptak's experience in the refining field goes back many years. As a result, the experience learned on the job by B-L engineers produces an intelligent application of product to problem.

Castable materials are rated to the job they must do. They form a smooth monolithic wall adaptable to any contour.

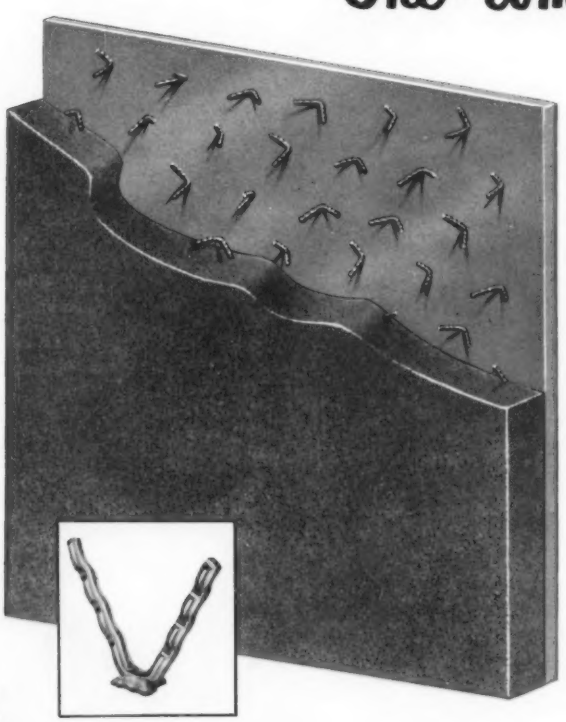
Construction crews work in almost all parts of the world using modern methods and equipment. They are headed by capable Bigelow-Liptak engineers thoroughly schooled in refinery work. All together this B-L service means real dollar savings—one source—one contract—one responsibility.

Two-component castable linings

Bigelow-Liptak uses castables designed expressly for answering the problems of the refining industry. In two-component linings, studs are welded to the inside of a steel shell. A layer of insulating refractory is gunned onto the shell and a retaining mesh is welded to the studs. An abrasion-resistant castable material is then gunned onto the mesh, finishing off the job. Installations of this type are particularly adaptable to catalytic regenerators, catalytic reactors, cyclones, stacks and similar refining equipment where castable can be applied.



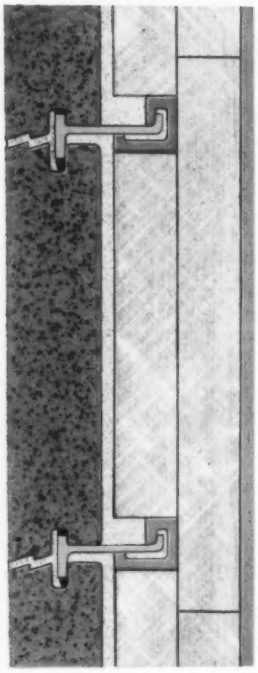
One-component castable lining

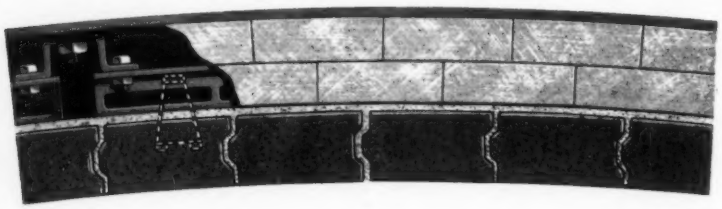


For installations requiring economy, yet extraordinarily long life, Bigelow-Liptak recommends a single component lining. Specially-designed V-anchors, alternately long and short, are welded to the steel shell on 10-inch centers. These anchors are cocked at various angles to eliminate the possibility of cleavage. Refractory concrete is gunned onto the shell and is held in place by the anchors. One-component castable linings can be used for vessel linings, ducts, breechings, etc.

Unit-suspended construction

The old proven stand-by for refinery installations is suspended construction. As with installations in other fields, each tile is individually hung from a supporting casting and can be removed without disturbing adjacent areas. Suspended enclosures offer the inherent features of low maintenance and high efficiency plus easy replaceability of small damaged areas. Parts can be pre-fabricated leading to minimized erection costs. Frequently, both castable and suspended construction are combined in the same furnace for maximum efficiency and economy.





YOUR NAME HERE

may save you time and money

When industrial furnace enclosure repairs become necessary today, there's a lot of satisfaction in knowing that they can be made efficiently—and quickly—under the supervision of the company which designed those enclosures.

If you are fortunate enough to have Bigelow-Liptak furnace enclosures in your plant—the entire record of the installation; its description and lists of all repair parts are at the finger tips of our production department—ready to be used at a moment's call to help you get your furnace back in efficient operation in a minimum of time.

Experiences like the recent predicament of one of the major oil refineries prove the value of this Bigelow-Liptak feature. By means of comprehensive Trade Cards—that cover every Bigelow-Liptak installation from one end of the world to the other—recommendations were made over the telephone to this refinery which was having difficulties because production during the last several years had forced operation to almost double its designed capacity. Necessary repair parts were indicated. A fully informed engineer was rushed to the job. And this aviation gasoline plant which had operated five years without repairs was back in service in four days at this greatly increased rating.

"Please accept our appreciation for the effort made to put this plant back in operation. It is nice to know we are dealing with companies and individuals who feel an interest and a responsibility in the jobs they have furnished," wrote the chief engineer of this great refinery.

BIGELOW-LIPTAK
CORPORATION
AND BIGELOW-LIPTAK EXPORT CORPORATION
13300 PURITAN AVENUE, DETROIT 27, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

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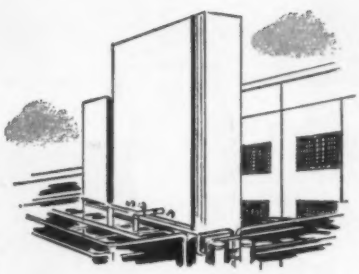
SAULT STE. MARIE • VANCOUVER • WINNIPEG

LITHO IN U.S.A. DO 1057

CO

Now you can produce CO more efficiently, simply, at lower cost



LONG THE BANE OF many chemical processes, carbon monoxide has suddenly become one of the most valuable raw materials of the ever-growing plastics and allied industries. More important still is its method of production by low-temperature gas separation, in which techniques perfected by Air Liquide during the past 50 years have resulted in unprecedented efficiency, tremendous economies and maximum purity.

Leading this highly specialized field in the United States, Air Liquide low-temperature gas separation plants, the first to be built in this country for the production of pure CO, have recently been completed in four widely separated locations, and a fifth is under construction.

Our entire technical and manufacturing staff, including design, process, project and mechanical engineers, backed by a half century of world-wide experience, is at your service to assist you in applying low-temperature technology to your particular needs — whether your product requirements are carbon monoxide, oxygen, nitrogen, hydrogen or other gases, or a solution to purification problems.

We shall be glad to consult with you regarding cost analyses and technical aspects in the design and manufacture of complete plants or components especially fitted to your needs. Write today for complete technical information on our CO plants.

In Canada:
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AMERICAN
AIR LIQUIDE
ENGINEERING & CONSTRUCTION DIVISION

OLDEST IN EXPERIENCE — NEWEST IN DESIGN

For more data on advertised products, use Readers' Service Cards, last page.

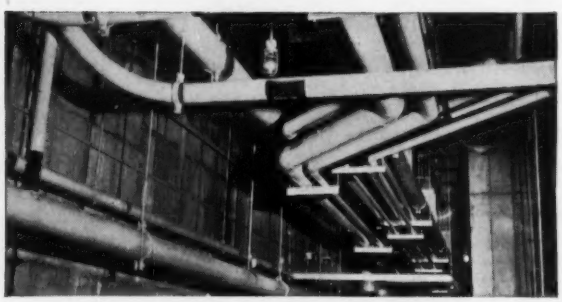
BLAW-KNOX has what it takes—to provide these products and services

A Blaw-Knox automatic sprinkler system could have prevented this disastrous fire. Each year a serious fire strikes one out of seven manufacturing firms in this country. And out of every 100 firms who lose their records in a fire, 43 never reopen for business. So why take any chances.

Blaw-Knox engineers, fabricates and installs automatic sprinkler systems that are always alert to detect, confine and quench a fire at its origin. Qualified engineers custom-design systems that meet individual requirements—and fulfill all insurance standards and municipal codes. A Blaw-Knox automatic sprinkler system pays for itself in a few years through savings in reduced insurance premiums.

Let a Blaw-Knox fire-protection engineer study your needs, submit a layout and estimate, and tell you how you can pay for the system on our lease or deferred payment plan. For more complete information, write for Bulletin No. 2426—"Fire Can Destroy Your Business."

Blaw-Knox trapeze functional spring hangers, with the patented internal swivel action, support power piping in new generating station. Our experienced engineers are available to both design and make recommendations for your hanger requirements. For further information, send for Catalog No. 54.



High temperature, high pressure oil tunnel piping in large steel mill is typical of many piping systems prefabricated and erected by Blaw-Knox. Experienced piping engineers, modern shop facilities and a new Blaw-Knox digital computer method for fast, accurate calculation of piping stresses are available to you. Let us know your requirements and we will provide the service you need. For additional information, write for Bulletin No. 2443—"Piping for Industry."

BLAW-KNOX

BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

829 Beaver Avenue • Pittsburgh 33, Pennsylvania

Complete facilities for prefabrication and erection of piping systems for all pressures and temperatures ... complete line of standard and custom-engineered pipe hangers, supports and vibration eliminators ... complete line of automatic sprinkler systems for standard and special hazards

Less Gear Shift—More Work Shift With a Bucyrus-Erie Hydrocrane

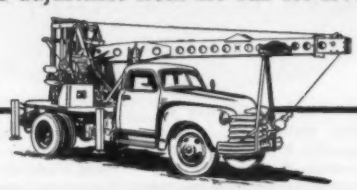
Ordinary crane carriers can't match a truck-mounted Hydrocrane for speed and maneuverability on the highway. The result—the Hydrocrane wastes less time in travel, gives you more profit hours of work.

Compact size so important in traffic gives you extra leeway for maneuvering on narrow roads and streets. Extremely short tail swing allows working close to buildings, tanks and other structures.

Outriggers can't drift down during travel. On the job they set down solidly in seconds, are adjustable from the cab for leveling crane on uneven ground.

Telescoping boom that retracts neatly over cab during travel extends and retracts hydraulically while working—reaches out for loads—slips under wires, beams and overhead lines; over trucks, pipes and other low obstructions.

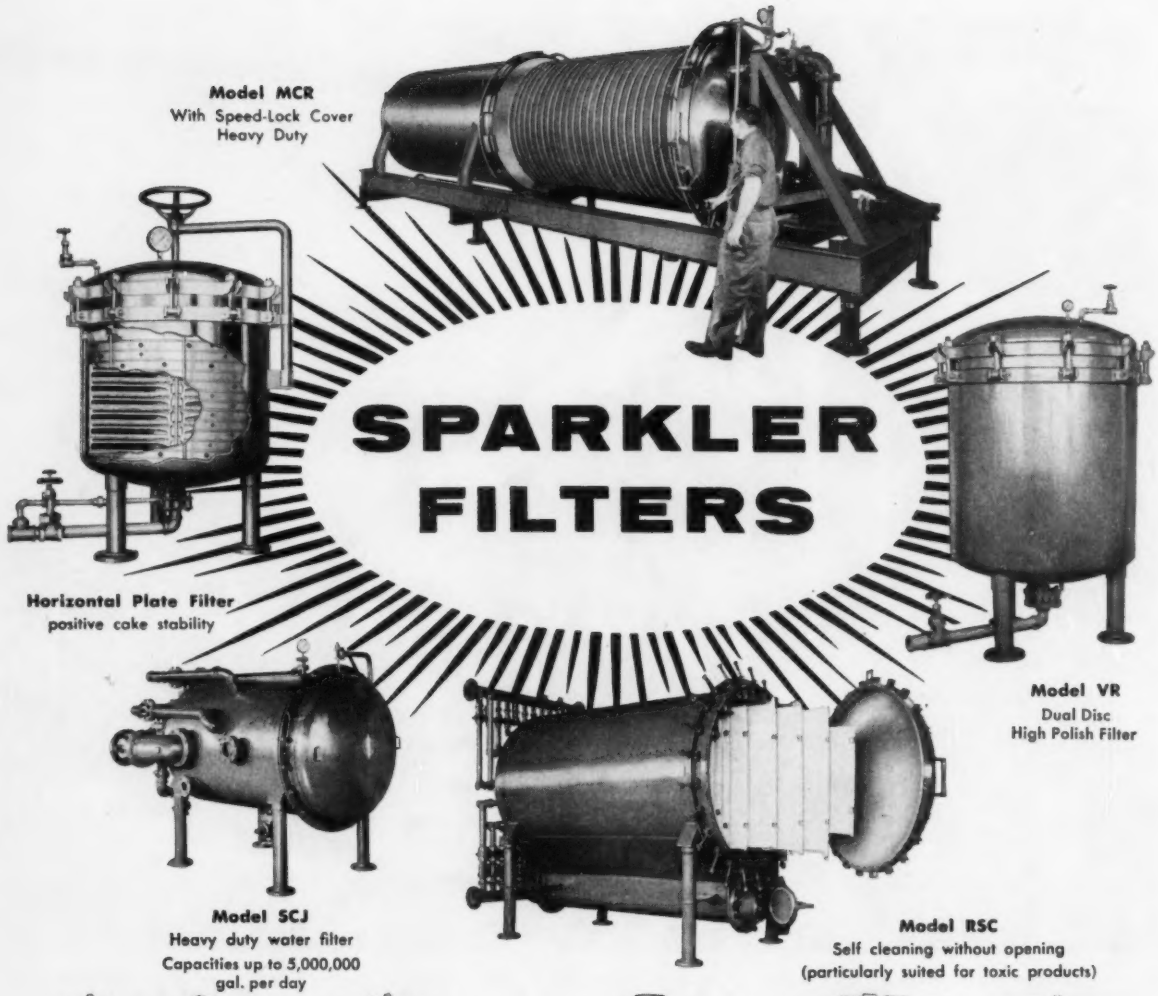
And there's plenty of capacity and reach. The 10-ton Model H-5 has a maximum boom length of 50 feet (plus 10- or 20-ft. jibs); the 5-ton H-3, 38 feet (plus 10- or 18-ft. jibs). Find out all the reasons why Hydrocranes are growing favorites in refineries. See your Bucyrus-Erie distributor for full details. 219H57



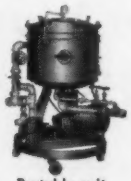
BUCYRUS ERIE

SOUTH MILWAUKEE, WISCONSIN

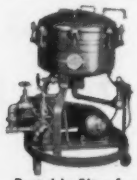
For more data on advertised products, use Readers' Service Cards, last page.



Portable filter with slurry tank and feeder.


Portable unit, explosion proof.

Portable unit corrosion proofed, rubber lined with plastic plates.


Portable filter for polishing operations.

Low cost Vacuum Filter.

The most complete line of filtration equipment- engineered to meet the requirements of hundreds of products

By concentrating on filtration engineering and manufacturing exclusively for over 30 years, Sparkler is able to offer a solution to practically all filtration problems without expensive experimentation.

Standard filter models available for:

Chemicals	Electroplating	Varnish
Pharmaceuticals	Petro Chemicals	and Lacquers
Beer,	Petroleum Derivatives	Hydraulic Oil
Whiskey, Wines	Food Products	Steam Condensate

and many other products in addition to large volume water filtration for municipal and plant use. Personal service on all filter installations.

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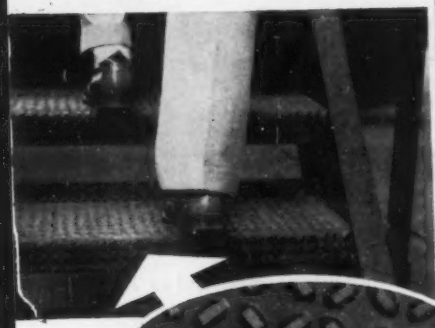
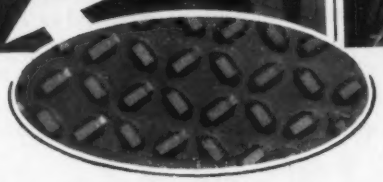
MULTIGRIP FLOOR PLATE is high-safety, low-upkeep factor at Gulf Refinery

Port Arthur, Texas . . . hometown of huge refineries. Here, rambling refinery units of Gulf Oil Corporation are connected by a labyrinth of catwalks, ladders, ramps, walkways and steps. Traffic lanes such as these call for durability, safety and cleanliness. That's why you see USS Multigrip Steel Floor Plate wherever you look.

Multigrip tough steel floor plates have flat-topped, clean-edged risers that mean safe traction *from any direction.* The plates stand up under rugged service, year after year, without chipping, cracking or splintering. And cleaning them is a breeze—a hose or broom does the job. You can cut, weld, bend or shape Multigrip with ease, and large plates mean minimum installation waste. For increased safety and reduced maintenance . . . specify USS Multigrip Floor Plate.

Flat-topped risers give years of accident-free service.





Multigrip is available in large plates, eliminating waste of material and providing quicker installation, thus reducing cost.

Multigrip may be cut, bent, formed or welded.

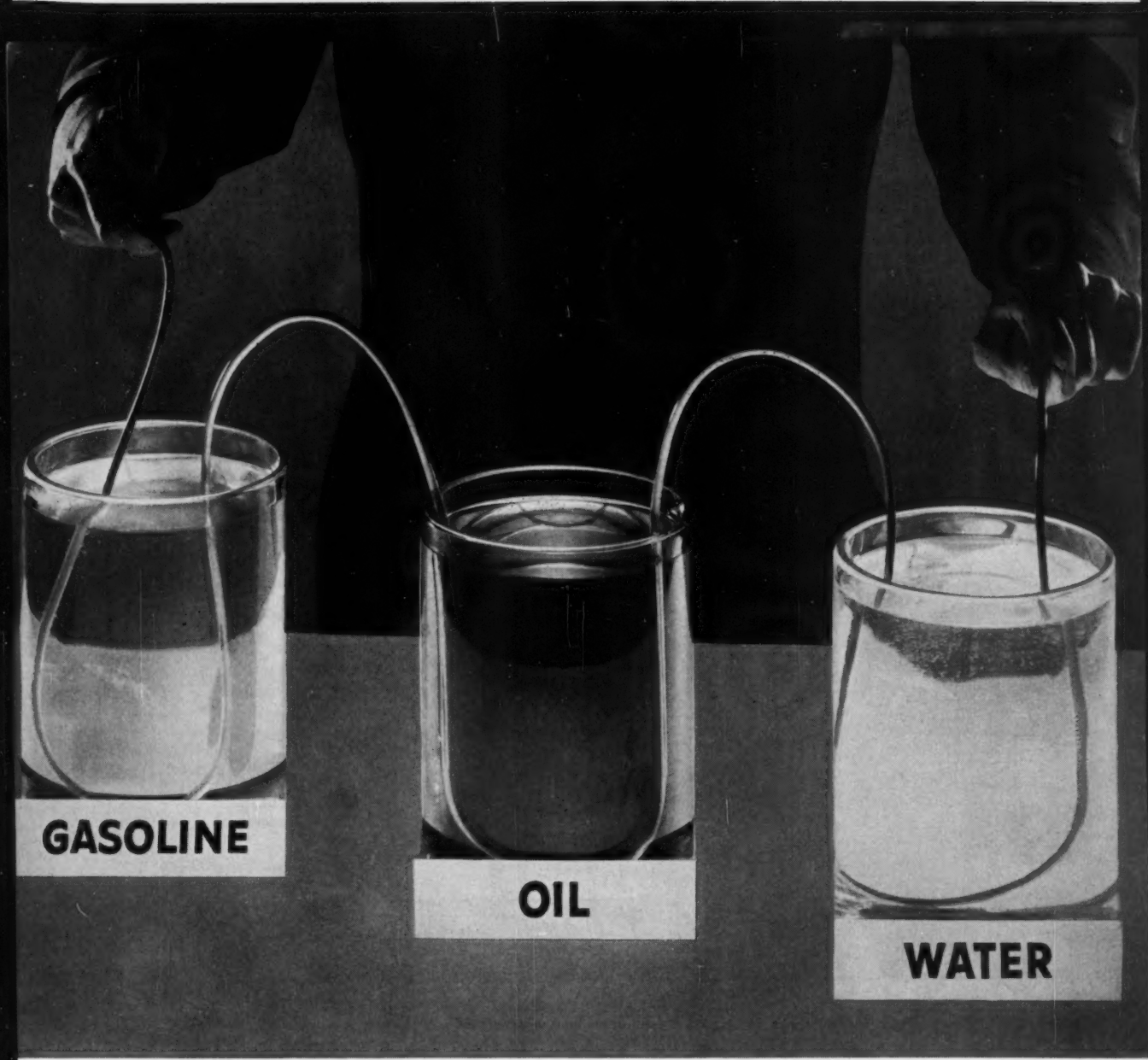
UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, CHICAGO
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

7-209

USS multigrip FLOOR PLATE

Sold by leading distributors from coast to coast

UNITED STATES STEEL



DENTROL WIRE—submerged in gasoline, oil, water—proves resistant to all 3.

New Dentrol thermoplastic wire RESISTS ALL 3—GASOLINE, OIL, WATER!

Dentrol wire affords *new safety* wherever wiring is exposed to gasoline or oil—*new economy* over the lead-covered cable you're now using in these areas.

Made with a clear nylon jacket over-all, Dentrol not only beats gasoline, oil and moisture—but is exceptionally resistant to abrasion. It is easily installed (hard, smooth finish makes pulling through conduit simple), easily stripped, lightweight for easy handling.

Suggested uses: for 600 volt wiring for lighting, power and control in and around service stations, refineries, tank farms, and industrial plants.

Dentrol is Underwriters' Laboratories approved as TW and "gasoline-resistant" wire for use in open raceways where exposed to gasoline or gasoline vapors. Thus it meets the provisions of section 5023 of the 1956 National Electrical Code, concerned with installations in hazardous locations.

Available in colors, and in 500′ cartons. See your Anaconda distributor. For information write: Anaconda Wire & Cable Company, 25 Broadway, N. Y. 4, N. Y.

57894 Rev.

LIVE BETTER ELECTRICALLY

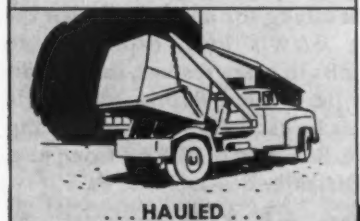
SEE THE MAN FROM **ANACONDA®**
FOR **DENTROL WIRE**

The TEXAS COMPANY "CONTAINERIZES" Waste as It Accumulates

Port Arthur Refinery "Containerizes" Waste, Rubbish and Liquids at Many Accumulation Points . . . Hauls and Dumps Them With Dempster-Dumpsters

WASTE IS CONTAINERIZED . . .

. . . PICKED UP . . .



. . . HAULED . . .

. . . AND DUMPED . . .

Dempster-Dumpster Waste Disposal System Serves Leading Refineries & Chemical Plants

Waste disposal and plant cleanliness can no longer be efficiently maintained by wheelbarrows, cans, carts, or bins. Shoveling, re-handling and on-site dumping have been replaced in leading plants by "Containerization" of waste as it accumulates. By placing clean, big-capacity Dempster-Dumpster containers at accumulation points, you can save thousands of dollars annually and enjoy improved plant cleanliness.

The one-man, one-truck Dempster-Dumpster can service over a hundred accumulation points, picking up, hauling and emptying the containers on a planned shuttle schedule. Chemical plants and refineries customarily amortize their equipment investments in 18 months or less. Write today for the free booklet, below.

FREE: Write Today for Your Copy of
"How to Reduce Waste Disposal Costs."

DEMPSTER BROTHERS, Knoxville 17, Tenn., DEPT. PR-11

THE DEMPSTER DUMPSTER® SYSTEM

To: Dempster Brothers, Dept. PR-11
Knoxville, Tennessee

Please Send Without Obligation Your Booklet, "How to Reduce Waste Disposal Costs."

NAME..... TITLE.....

COMPANY.....

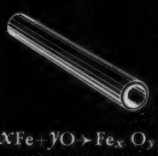
ADDRESS.....

CITY..... STATE.....

For more data on advertised products, use Readers' Service Cards, last page.

PRESSURES

TEMPERATURES



OXIDATION

CORROSION RESISTANT

SIZE

At B&W—You Can Get - - - The Right Tube For The Job

Pressures, temperatures, oxidation, corrosion resistance, and tube size are important factors the design engineer must consider in specifying tubing for process equipment applications.

For example, one company was faced with a serious problem. Stainless tubing used for conveying methanol and unreacted synthesis gases at 300F and 5000 psi through chloride-bearing bayou water failed due to stress corrosion.

What did they do?

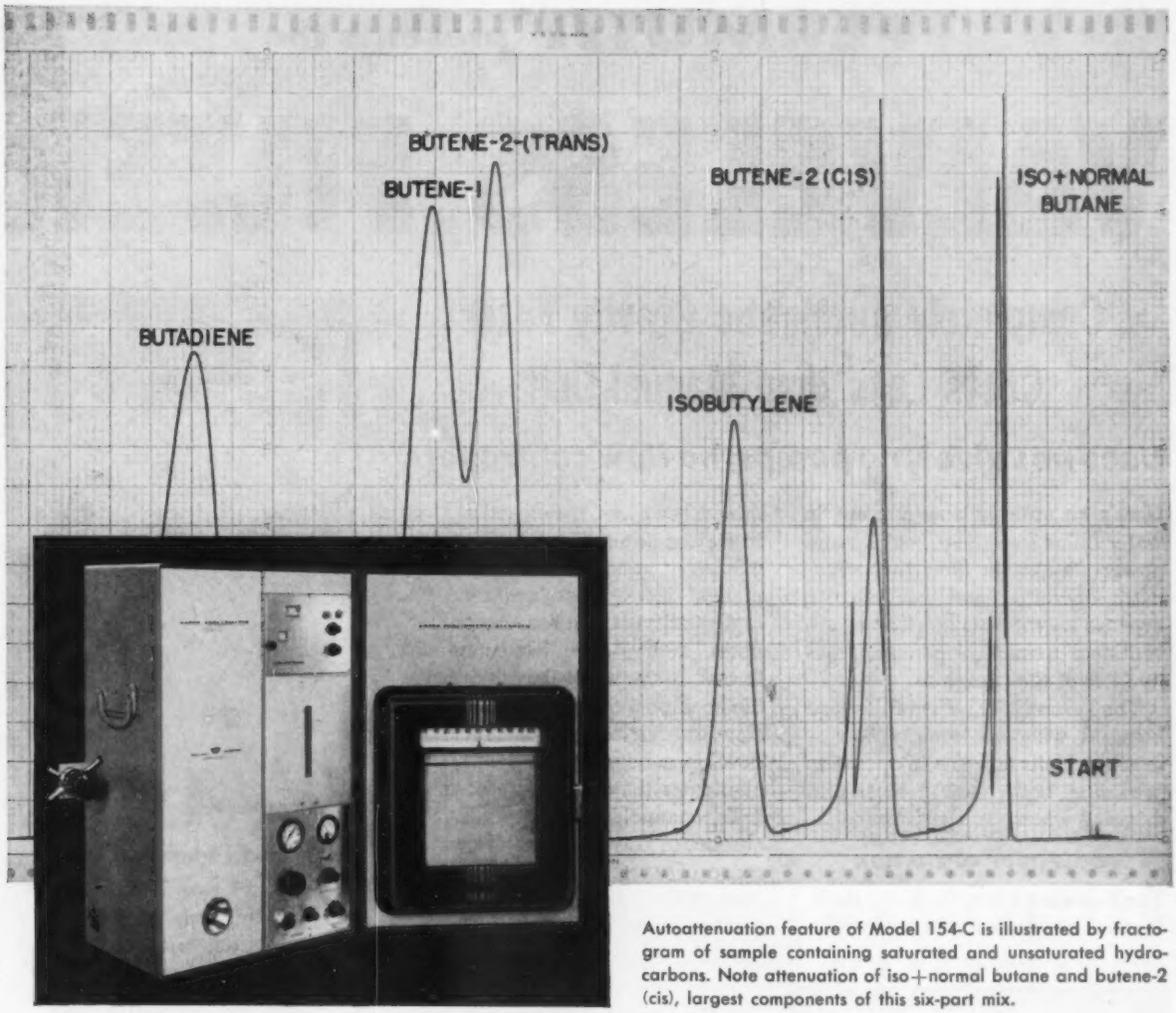
Just what many other companies have done—they called in Mr. Tubes, a B&W Tube Representative. He suggested B&W Croloy 5 as the best material for the job.

The new tubing provided the desired resistance to the particular type of corrosion and satisfactorily met all temperature and pressure requirements. What's more, the new installation proved to be substantially lower in materials costs.

B&W, with its years of experience in all phases of tube requirements, is especially qualified to help you choose the right tubing for any job. To get the most benefit from B&W's long experience in matching tubes to jobs in every respect, call on Mr. Tubes, your nearby B&W Tube Representative. He has helped others, as he can help you, make tubing selection *surer*. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-7010-PP4

Seamless and welded tubular products, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels



Autoattenuation feature of Model 154-C is illustrated by fractogram of sample containing saturated and unsaturated hydrocarbons. Note attenuation of iso+normal butane and butene-2 (cis), largest components of this six-part mix.

Automatic Range Control Accessory for P-E Model 154-C

PERMITS UNATTENDED OPERATION

Detecting and calculating parts-per-million in gas chromatography has always demanded constant attention to manual range control, keeping *major* component peaks of the fractogram *on scale* where they can be measured.

Such continuous undivided occupation with range control is annoying, time-consuming and wasteful. Now Perkin-Elmer makes it *unnecessary*—with an Automatic Range Control accessory for the new Model 154-C Vapor Fractometer. Analyst time and temper are saved by a device that keeps big peaks on scale *automatically*. Perkin-Elmer Automatic Range Control means attention-free chromatographic analysis, speeding up routine work and relieving the analyst of a time-consuming, uneconomical chore.

Add automatic range control to other outstanding features of the brand-new Model 154-C Vapor Fractometer, and it is evident why this Perkin-Elmer instrument is first in its field. For example:

- NEW precision temperature control keeps column temperature level within 0.1° C.
- NEW high temperature column accessory analyzes liquids and solids boiling up to 425° C.
- NEW copper oxide combustor handles complex hydrocarbon analysis.
- NEW versatility with fifteen different column stationary phases for all types of problems—and sampling accessories for top accuracy and reproducibility.

Write us at 880 Main Avenue, Norwalk, for complete details in a new brochure on Perkin-Elmer Vapor Fractometers.

INSTRUMENT DIVISION
Perkin-Elmer *Corporation*
NORWALK, CONNECTICUT

For more data on advertised products, use Readers' Service Cards, last page.

PERMUTIT® presents the

VALVELESS FILTER

Completely Automatic Gravity Filter Costs Less than Manual Unit

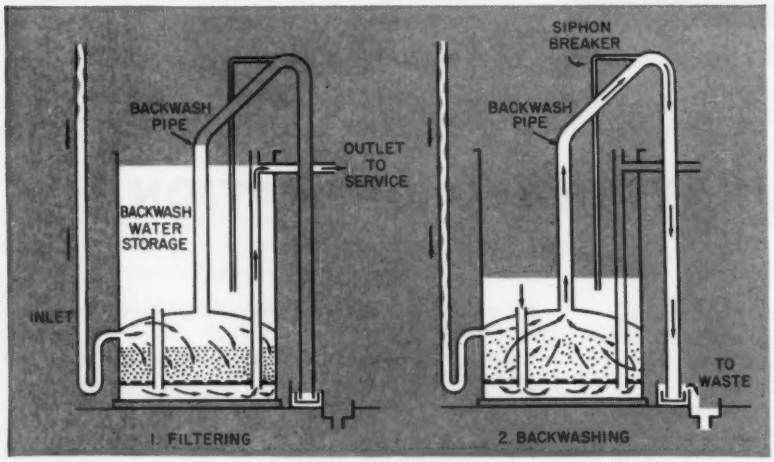
Uses no valves, no pumps, no flow controllers

Here's an entirely new concept in water filters for cities, factories and power stations: a filter that *eliminates* operation and maintenance expense . . . yet costs *less* than a conventional manually-operated gravity filter of the same size.

The Permutit Valveless Filter can be used wherever gravity flow is feasible. Units are now in operation providing both plant process and drinking water.

FOOLPROOF OPERATION

The Valveless Filter thinks for itself. It starts backwashing at a predetermined head loss, rinses and returns to service automatically . . . and as efficiently as an expertly operated manual filter. It assures uniform, high quality effluent because it eliminates "human error." It cannot be forced. It cannot backwash or rinse too soon or too late, too fast or too slow, too much or too little. It cannot develop a negative head and thus eliminates the chief cause of mudballs, channelling, upset beds. The absence of gravel eliminates another cause of upset beds. Backwash or rinse water cannot be accidentally run to service.



HOW IT WORKS

Filtering. Water enters at left, flows through sand, strainers and false bottom up effluent duct to service. As head loss increases during run, water rises in backwash pipe. At maximum headloss, water spills into downward section of backwash pipe and starts backwash (siphon) action.

Backwashing. Siphon draws water from storage down through ducts, up through strainers and sand to expand and wash bed, then to waste. At low storage level, air enters siphon breaker to stop backwash. Flow reverses and filtered (rinse) water flows into storage until full. All flow then goes to service.

PROVEN PERFORMANCE

Photo shows two Valveless Filters in a large industrial plant. (Shut-off valve at left is used only to take front filter out of service.)

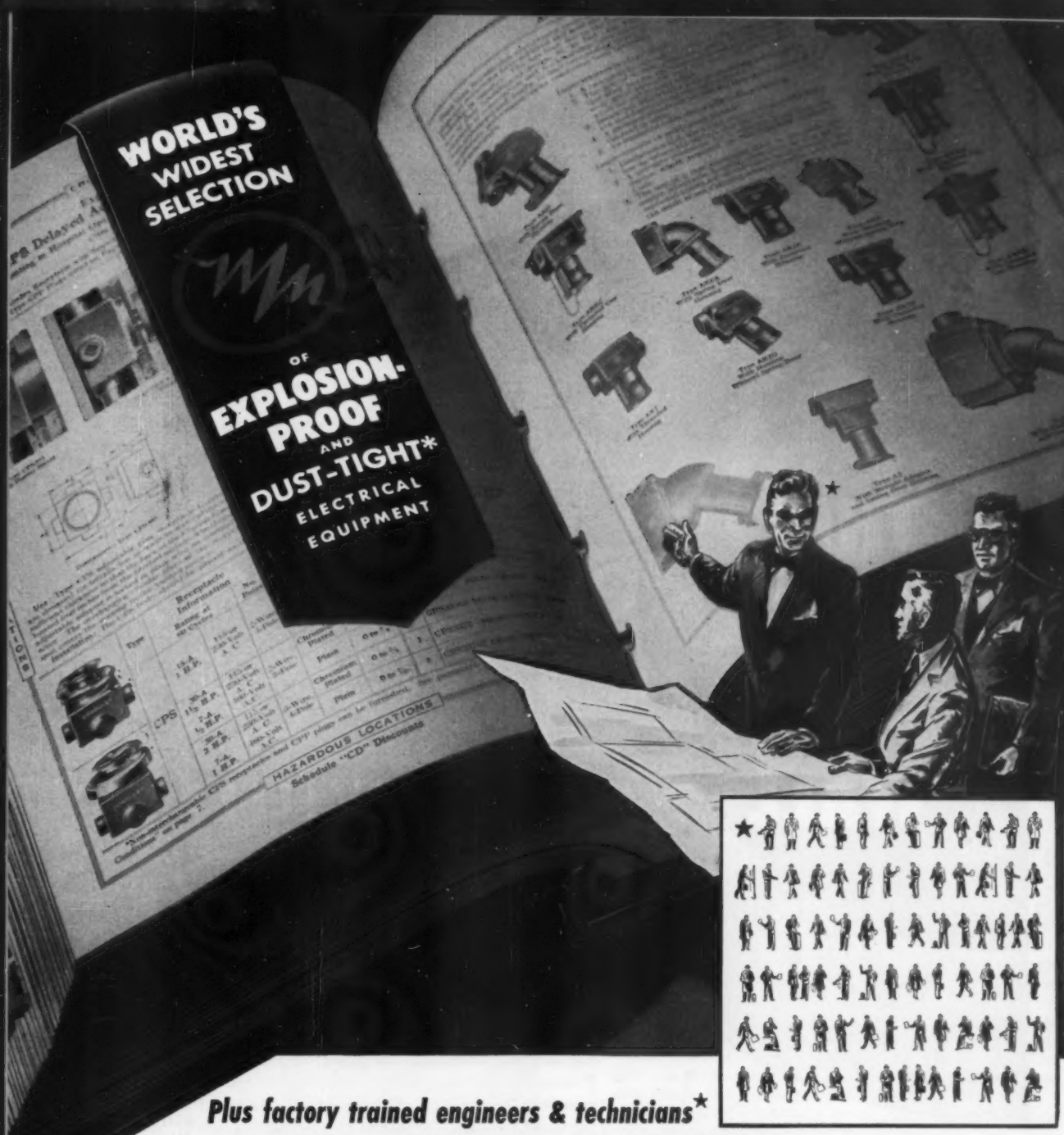
LOW INSTALLATION AND EXPANSION COST

Filters up to 10 ft. diameter are shipped set up. Piping is simple. Future filters are easy to add since they require no additional backwash water storage or pump capacity. Filters use minimum floor space.

FREE BULLETIN

New bulletin, "The Permutit Valveless Filter," includes details, drawings, operating conditions, capacities. Address: The Permutit Company, Dept. PR-11, 50 West 44th St., New York 36, N. Y. or Permutit Company of Canada Ltd., Toronto 1, Ont.

PERMUTIT®
rhymes with "compute it"
A DIVISION OF PFAUDLER PERMUTIT INC.
Water Conditioning
Ion Exchange • Industrial Waste Treatment



Plus factory trained engineers & technicians to assist you in selecting the types best suited to your needs*

There are more than 17,000 items in the Crouse-Hinds line of Condulet® and floodlighting equipment. Each is designed with some specific advantage or quality that makes it best suited for a particular application.

Of course, no engineer, electrician or contractor with a regular job to do, could possibly keep in mind all the pertinent data and information concerning each of these items. That's why Crouse-Hinds maintains a factory-trained field staff of 80 graduate E.E.'s and technical men.

Their job is to confer with the users of Crouse-Hinds equipment and to point out the reasons why certain Condulet equipment or floodlights are better suited for a particular job than others. With a broad grounding in the details of the National Electrical Code and a trained alertness for spotting explosion hazards in unsuspected places, they make a consulting or factory-engineer's job less onerous.

Their service is prompt and without obligation. Naturally they usually work on jobs of sufficient size to merit top-level attention, but even a small job with a large problem gets the same careful appraisal. If you'd like to talk or correspond with such a specialist, just write, wire or phone.

CROUSE-HINDS COMPANY

*Dust-ignition-proof

Main Office and Factory: Syracuse, N. Y.
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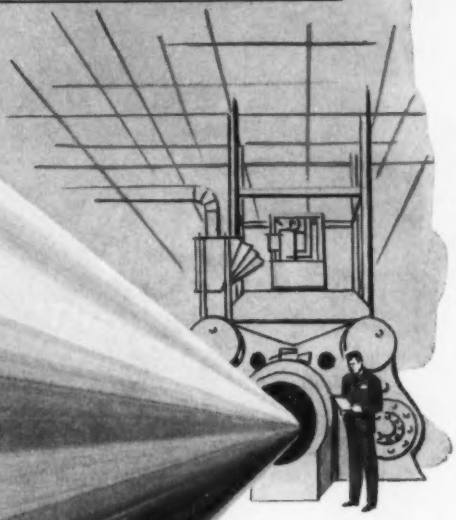
FOR YEARS OF PIPE ECONOMY...



THIS EXTRUDED HEAVY WALL

PROTECTS

against severest heat, pressure and corrosion

Here is High Integrity pipe for the toughest applications in the power, petroleum, chemical and other industries. Extruded from any ferrous alloy in lengths up to 50 feet or more, and with virtually any wall thickness, this pipe from the Curtiss-Wright Metals Processing Division provides increased on-the-job life, long-term economy, elimination of down time – not just for months, but for years to come. Extruded to specification under tremendous one-push pressures from the Division's giant 12,000-ton horizontal steel extrusion press, Curtiss-Wright Heavy Wall Pipe is of uniform high strength and has high resistance to pressure, heat and corrosion. Write today for information on both your standard and special requirements.

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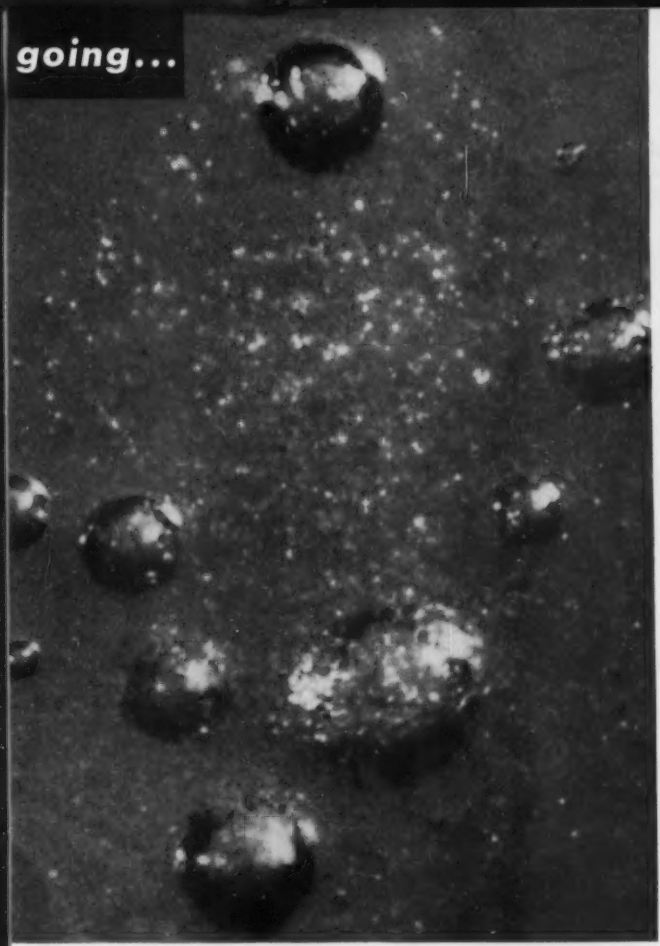
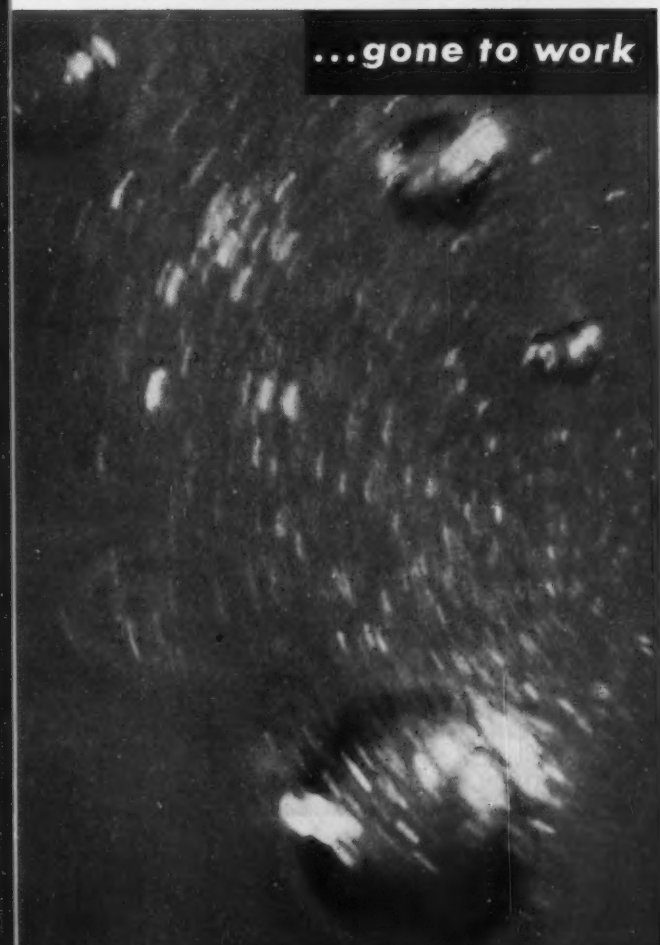




Why refineries everywhere are giving DALPAC* a whirl

These dramatic microphotographs show how a single flake of Dalpac 4 antioxidant is speedily dissolved into the gasoline stream.

Produced by Hercules from its own basic source of pine chemicals, Dalpac 4 effectively inhibits gum formation, maintains engine cleanliness, and stabilizes gasoline color. A major advantage is that Dalpac will not form deposits in fuel intake systems.

Dalpac 4 type inhibitor meets military specifications for aviation gasoline and jet fuel. It prevents decomposition and sludging in turbine oils. It retards sludge and peroxide formation in transformer oils without changing their electrical properties.

You will find Dalpac 4 also effective in petroleum waxes, brake fluids, hydraulic oils, slushing oils, cutting oils—almost any petroleum product where resistance to oxidation is desired.

Dalpac 4 is shipped from Gibbstown, New Jersey and Hattiesburg, Mississippi, and is available in solid and liquid forms. This antioxidant is made from Hercules' own basic source, para-cresol. Buying Dalpac 4 from Hercules is your assurance of both supply and top quality. **Hercules Trademark*

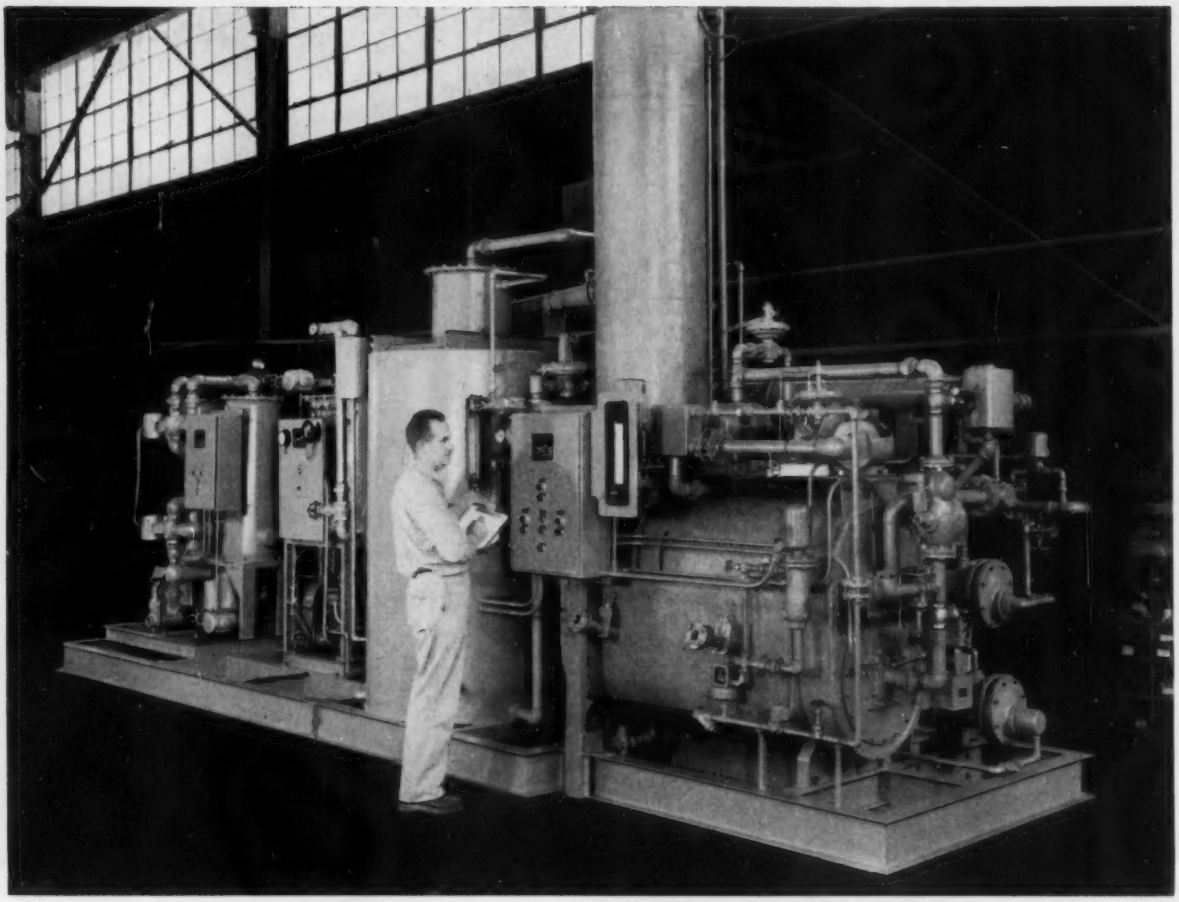
Oxychemicals Division Naval Stores Department

HERCULES POWDER COMPANY

INCORPORATED

900 Market Street, Wilmington 99, Delaware

NO57-6



Complete nitrogen system includes LN300 generator and drying equipment on a common base, factory tested, ready for fast, simplified installation.

Here It Is...The Finest Nitrogen Generator Ever Built

No other nitrogen generator brings you all the advantages of Gas Atmospheres' advanced unitized design. Here's more generator in less space . . . actually 20% less floor space required, yet all operating and maintenance points are easily accessible.

It's factory built on a common base . . . just set it in, connect utilities and process gas piping and it's ready to go. All controls and measuring devices are centrally located. Simplified combustion control assures ultimate safety and high purity analysis. Exclusive air-fuel control guarantees precise ratio adjustment . . . eliminates complicated, troublesome carburation system.

Fuel-air mixing is accomplished at the burner for highest safety. This also permits the use of a wide range of fuels including natural gas, LPG, hydrogen and light fuel oils.

Complete purification at any flow rate is assured by Gas Atmospheres' exclusive absorbing system.

These are a few of the many reasons why you'll want to talk with a Gas Atmospheres' engineer when next you're considering nitrogen generator equipment. Write for your copy of new Nitrogen Generator booklet today.

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equipment for producing industrial gases
20011 WEST LAKE ROAD CLEVELAND 16, OHIO

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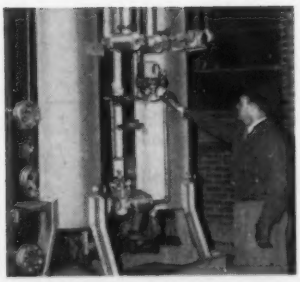
Some of the many available desiccants

It takes an expert prescription to dry gas properly . . .

Come to Kemp



Kemp Model 300 S Dryer protects pneumatically operated instruments at Sun Oil's Marcus Hook Plant. This unit has operated continuously since installation with little or no attention, giving specified performance at all times.

Over 20 *different* desiccants . . . each with its own particular properties and uses. It takes experience to choose the right one and engineer it into a drying system that will exactly meet your needs.

Kemp offers you that experience . . . almost a quarter-century in designing and building drying apparatus. Kemp engineers combine the right equipment and the right desiccant into a unit that brings you dependability, ease of maintenance, and simplicity of operation. For any use . . . guarding pneumatically operated instruments and tools . . . drying process gasses and inerts for blanketing and purging . . . pressurizing anhydrous liquids . . . liquid drying or any of a host of other applications . . . a Kemp Oriad or Convection type dryer will give you high efficiency drying at low cost.

To improve performance and cut costs in your operation, have Kemp engineers recommend a system for your plant. Your Kemp Representative will give you detailed information, or write direct for Bulletin D-100. The C. M. Kemp Mfg. Co., 405 East Oliver St., Baltimore 2, Md.

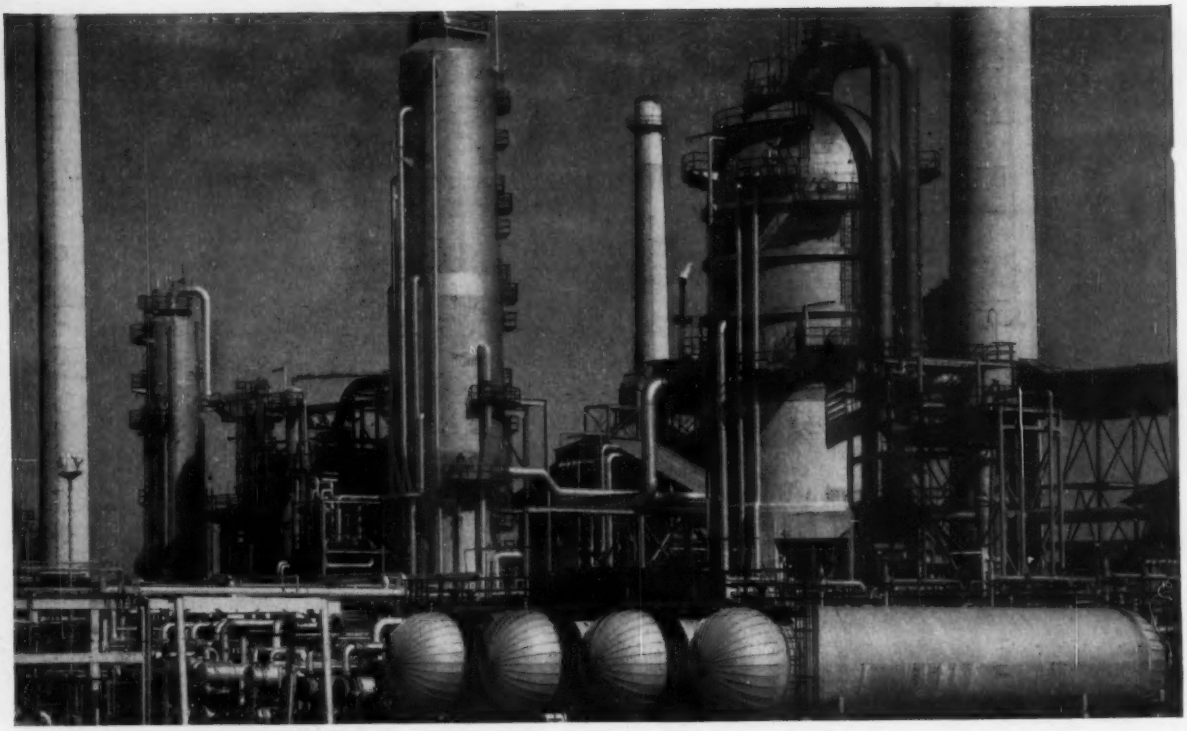
Kemp Convection Dryers

Kemp Inert Gas Generators

KEMP
OF BALTIMORE

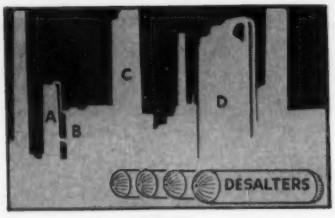
Kemp Industrial Carburetors

Kemp Oriad Dryers



The new Delaware Refinery . . .

Where Tidewater placed high nickel alloys to combat corrosion in world's largest crude unit



This is the crude unit . . . world's largest . . . in the ultra-modern Delaware Refinery.

It's the last word in corrosion protection. In engineering this protection, The Tidewater Oil Company and C. F. Braun & Co. took full advantage of high nickel alloys. In general, they used these materials to combat corrosion by dilute mineral acids and by the sulfur and naphthenic contents of the feeds. The schedule below gives details.

For further information . . . for help in your own corrosion prevention engineering . . . write Inco's Development and Research Division.

The International Nickel Company, Inc.
67 Wall Street INCO New York 5, N. Y.

Schedule of high nickel alloy use* in the crude unit at Delaware Refinery

Key	Equipment	Location	Principal Corrosives	Material
A	Gasoline Col.	Shell and trays above tray 13	H_2S, aqueous HCl	Monel alloy
		Nozzle sleeves in OH accum.	H_2S, aqueous HCl	Monel
		Water draw pot	H_2S, aqueous HCl	Monel-clad steel
		Foul water pump	H_2S, aqueous HCl	Monel alloy
		OH-to-receiver piping	H_2S, aqueous HCl	Monel alloy
B	Gasoline Stab.	Shell and trays above tray 7	H_2S, aqueous HCl	Monel alloy
		Shell and trays below tray 8	Naphthenic acid	Inconel alloy
		Nozzle sleeves in OH accum.	H_2S, aqueous HCl	Monel
		Reboiler tubes, sheets, flohead	Naphthenic acid	Inconel alloy
		Reboiler shell	Naphthenic acid	Inconel-clad steel
		OH-to-receiver piping	H_2S, aqueous HCl	Monel alloy
		Reboiler liquid and vapor piping	Naphthenic acid	Inconel alloy
C	Atmospheric Col.	Foul condensate pump	H_2S, aqueous HCl	Monel alloy
D	Vacuum Col.	Condensate pump bowls and impellers (1st, 2nd, and 3rd stage)	H_2S, aqueous HCl	Monel alloy
All — elements		Foul condensate pumps	H_2S, aqueous HCl	Monel alloy

*Where temperatures go above 500°F. nickel-containing Type 316 stainless and stainless-clad steel is also extensively used in this unit.

INCO NICKEL ALLOYS

$AlCl_3$

ALUMINUM CHLORIDE

The increasing use of Aluminum Chloride and the many new uses being found for it have led to a large increase in demand. In response to the need, Stauffer has increased production and refining capacity...is today, indeed, the country's largest producer.

PROMPT shipments of Anhydrous Aluminum Chloride are made from Houston, Baton Rouge, Niagara Falls and Elkton, Md., in drums of 600, 100 and 50 pounds net capacity.

Stauffer's Anhydrous Aluminum Chloride is made in granular or powder form, in six grades and numerous mesh sizes. Aqueous Aluminum Chloride is available on the West Coast only. Typical analyses of all grades of Stauffer's Aluminum Chloride comfortably surpass all specifications as to minimum $AlCl_3$ content, and maximum impurities.

Stauffer is also a major source of chlorides of Antimony, Boron, Silicon, Titanium and Zirconium. We shall presently publish a brochure on Metallic Chlorides and shall be glad to supply copies on request.

stauffer means service

Stauffer CHEMICALS SINCE 1885

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, N. Y.

Prudential Plaza, Chicago 1, Ill. • 636 California Street, San Francisco 8, Calif.

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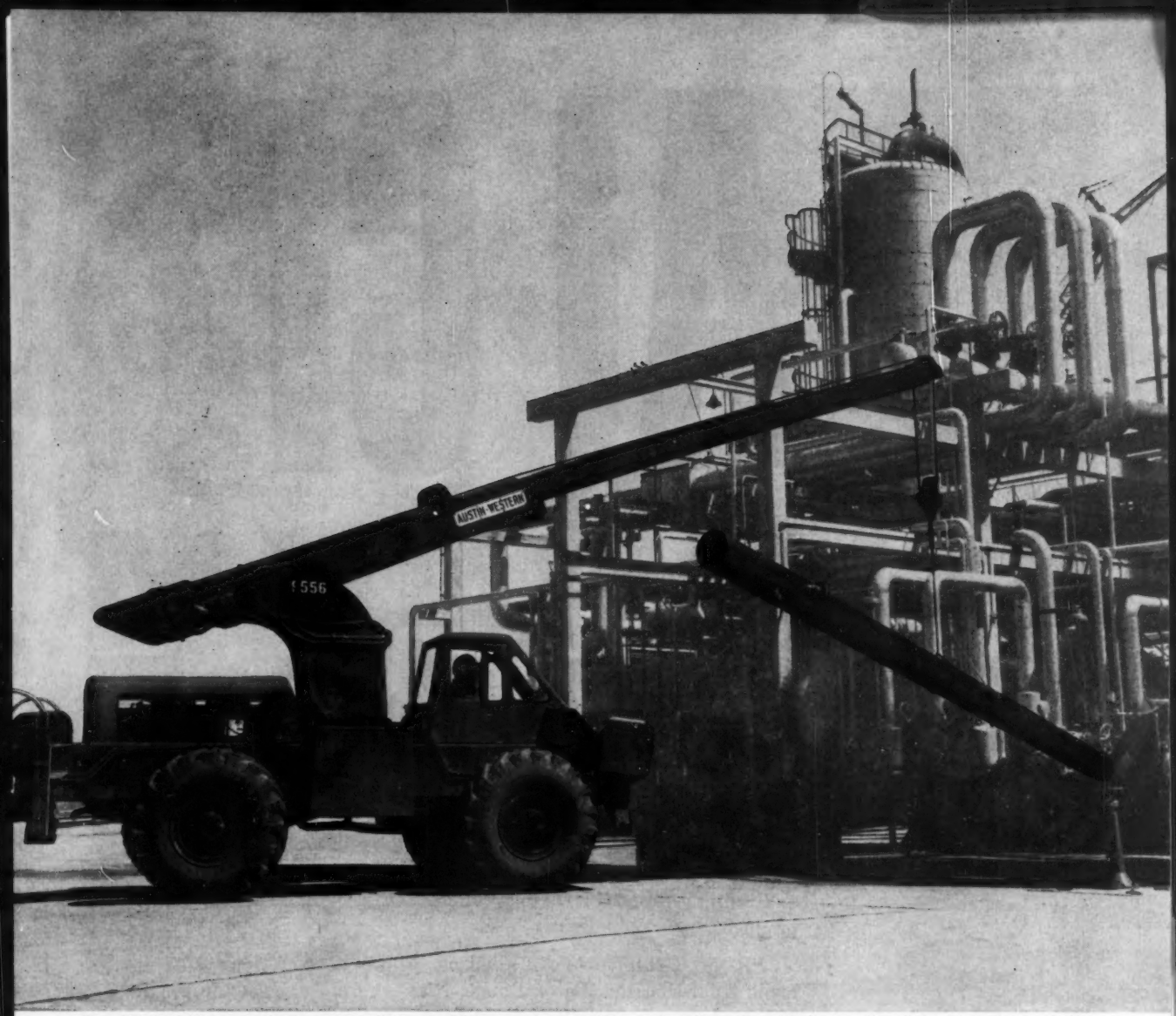

One of 7 Austin-Western hydraulic cranes at Tidewater Oil Company's new Delaware City refinery shown hoisting a section of pipe at a catalytic cracking unit.

AUSTIN-WESTERN HYDRAULIC CRANE

One of Tidewater's most versatile construction and maintenance tools

Thirty-six Austin-Western hydraulic cranes helped build Tidewater's giant refinery near Delaware City, Del., and seven are now steadily employed handling materials and speeding repairs. They are among the most versatile construction and maintenance tools Tidewater has, and new jobs are being found for them every day.

Here are some of the ways Austin-Westerns save time and money on refinery operations: they remove heat exchanger heads and tubes quickly, eliminating the need for a larger crane or chain blocks; lift and transport pumps into the machine shop for repairs, spotting them precisely; unload freight cars, using their long, live booms fast and efficiently; transport materials with ease under lines in pump alleys and around pumphouses, over railroad tracks, in and out of buildings.

Find out how the flexible Austin-Western hydraulic crane can help you. See your nearby distributor or write direct.

Power graders • Motor sweepers • Road rollers • Hydraulic cranes

BALDWIN BLH LIMA-HAMILTON

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BALDWIN-LIMA-HAMILTON
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AURORA, ILLINOIS

ALUNDUM* High-Purity Fused Alumina

...has many important advantages that may benefit your own operations

ALUNDUM fused alpha alumina, one of many electrochemically refined materials produced by Norton Company, is gaining increased preference for many industrial uses.

It is available in a number of forms. Of these, 38 ALUNDUM grain has proved particularly successful in applications demanding high purity. Electrically fused from Bayer-processed alumina, this white grain is 99.49% pure Al_2O_3. It is insoluble in common solvents, extremely resistant to reduction and is an amphoteric refractory with high dielectric strength. Other characteristics include:

Melting point	about 3600°F.
Specific gravity	3.94
Crystal structure	hexagonal system (rhombohedral division)
Hardness	9.0 Mohs' scale
Index of refraction	1.76 mean

Norton Also Electrochemically Refines

CRYSTOLON* silicon carbide, MAGNORITE* magnesium oxide, NORBIDE* boron carbide, FUSED ZIRCONIA and many others, including a number still under development. Having varied applications in many fields, these high-melting materials are also basic ingredients of the famous Norton Refractory Rx's — refractories *engineered and prescribed* for the widest range of uses.

For Your Own Requirements

Norton Company not only supplies these materials in crude form but is ready to work with you in processing or fabricating them to your own particular requirements. The new booklet, *Norton Refractory Grain — Electrochemically Refined,* brings you detailed information. Write for your copy to NORTON COMPANY, Refractories Division, 472 New Bond Street, Worcester 6, Massachusetts.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

Thanks to the inherent hardness, chemical stability and high density of Norton high-purity fused alumina, engineers in various fields are finding it widely useful. For example:

For Catalytic Reactions

Norton fused alpha alumina carriers are outstanding for chemical stability and resistance to abrasion and erosion. Available in the form of spheres, rings and pellets they are used in fixed bed oxidation reactions where the application requires a low surface area (less than $1 m^2/gm$) carrier. Inert, dense ALUNDUM spheres are also available for space filler applications. Other types of ALUNDUM catalyst carriers having surface areas in the range 5–60 m^2/gm are also available.

In Thermal Cracking Reactors

Particularly in Wulff Process Generators for cracking light hydrocarbons to produce acetylene gas and Koppers-Hasche Generators for cracking light hydrocarbons to produce a variety of gases and petrochemicals — checkers made of Norton ALUNDUM high-purity fused alumina provide definite advantages. Their excellent heat transfer properties, high refractoriness and resistance to erosion caused by hot gases are important. Their ability to withstand the thermal stresses of intermittent operation assures long life. And their purity prevents side reactions with the reacting gases, thus safeguarding product quality.

In Pebble Heaters

ALUNDUM heat exchange pebbles are giving excellent results in pebble heaters for heating gases above operating temperatures permissible in conventional tube furnaces. Their great resistance to abrasion, impact and repeated heating and cooling make them the ideal heat transfer medium in these devices. Also, their high refractoriness prevents them from the softening and "bridging" together that causes stoppages in the heater's moving bed.

In Gas Synthesis Generators

ALUNDUM fired shapes, backed up with ALUNDUM insulating castable, provide ideal linings for generators of this type because of their high-purity, high refractoriness, chemical stability, and inertness to reaction with contacting atmospheres.

Many Other Uses

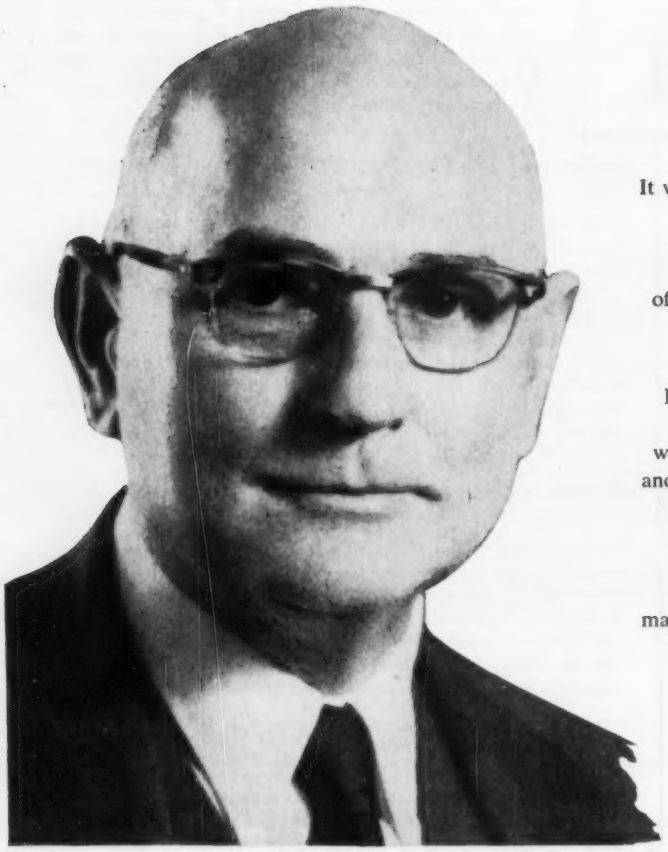
for Norton high-purity fused alumina materials include: pure oxides and sintered refractories, refractory cements, wear-resistant parts, laboratory ware, etc.

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed
Making better products . . . to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Grinding Machines • Refractories
BEHR-MANNING PRODUCTS: Coated Abrasives • Sharpening Stones • Behr-cut Tapes

For more data on advertised products, use Readers' Service Cards, last page.

A Tribute



John W. Newton
President and General Manager
Norvell-Wilder Supply Company

I want to pay tribute to an institution that has contributed immeasurably to the advancement of the oil industry — the American Petroleum Institute.

It was my good fortune to have served the A.P.I. as vice president of the refining division and as a director. So I know how many hours of hard work are done by men serving as officers and on committees. A good example of their accomplishments is the standardizing and development of equipment.

I know the value of this work from my having been on the *buyer's side of the fence* while serving for two decades as vice president and general manager of refining for the Magnolia Petroleum Company. Now, it is my pleasant duty to know the value of the work done by the A.P.I. from the *seller's side of the fence* from my position as president and general manager of the Norvell-Wilder Supply Company.

My good wishes go out to members of the A.P.I. and all who are working diligently to further the progress of one of the world's most dynamic industries, and from the standpoint of the strength and security of our nation, one of the most important—OIL.

By John W. Newton

NORVELL—

GENERAL OFFICES: BEAUMONT, TEXAS

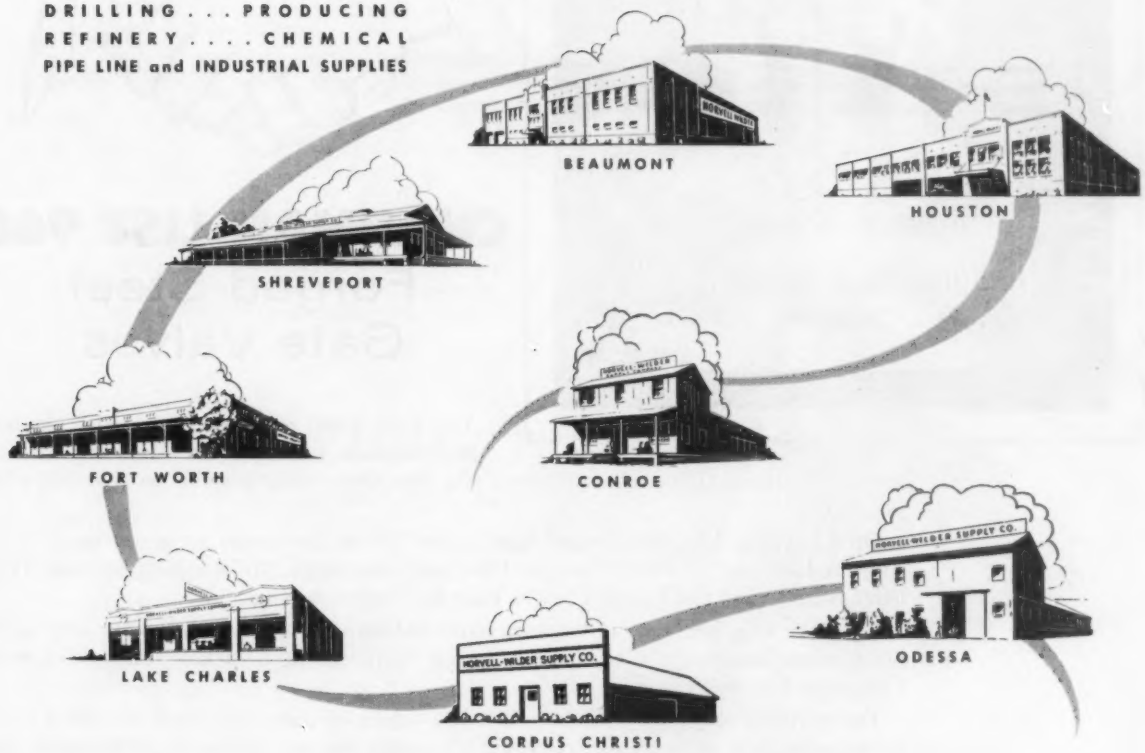
SERVING INDUSTRY SINCE 1910

to the

USE THESE BIG NORVELL-WILDER BRANCH WAREHOUSES

in convenient locations for service you can always depend on . . . for your

DRILLING . . . PRODUCING
REFINERY . . . . CHEMICAL
PIPE LINE and INDUSTRIAL SUPPLIES



WILDER

SUPPLY COMPANY

SALES OFFICES: DALLAS . . . PORT ARTHUR . . . TULSA

7917

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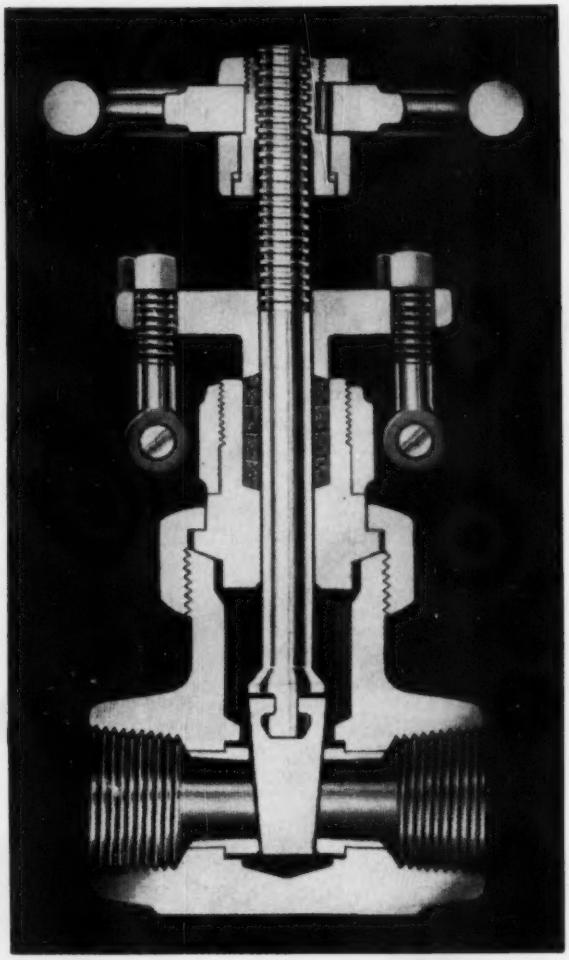


The Feeling is **MUTUAL**

CHAPMAN LIST 960
Forged Steel Gate Valves

You want small steel valves that give the best performance and cost the least for maintenance. Chapman thinks the same way and does everything possible to give you what you want.

On Chapman List 960 Forged Steel Gate Valves the wedge faces are *super* hard. They're hardened to 800 Brinell by Chapman's exclusive Malcomizing process. They can't seize. They can't gall. They're built for rugged service.

Even the long lasting seat rings are hardened stainless steel and are very easy to replace when necessary. Also, you have no full-pressure repacking difficulties with Chapman List 960 valves.

Today, there are more Chapman List 960 valves on more jobs than any other small forged steel gate valve. Valve men and Chapman see eye to eye on performance and costs. List 960's come in sizes from ¼" to 2". They stand up perfectly under conditions from 380 psi at 1000°F. to 2000 psi at 100°F. Of course, for higher pressures you use Chapman List 990 valves.

With the 960's you can order Bonnet joint either gasketed or ground metal-to-metal. You can have rising stem with yoke or rising stem with inside screw. You find them all in our Catalog 10. Write today for a copy.

The CHAPMAN
Valve Manufacturing Co.
INDIAN ORCHARD, MASSACHUSETTS

COLD-DRAWN SEAMLESS

STEEL TUBING

COLD FINISHED BARS

From the largest steel tube mill in the west comes seamless tubing in carbon, alloy and stainless steel tubing in a wide variety of chemistries and sizes. Also, electric resistance welded tubing is quickly available.

NEW SIZE: Pacific has added new facilities which raises the maximum size of available tubing to 4¼" diameter with a ½" wall.

If you require extra long tubing, Pacific is able to cold draw straight lengths up to 58' long. Patco tubing is "quality controlled" at every critical stage of manufacture to insure close tolerance, workability and long service life.

COLD DRAWN BARS

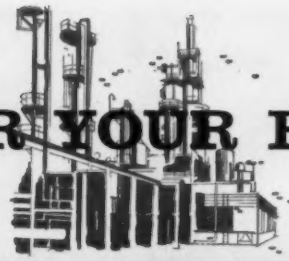
Precision drawn Patco round bars are quickly available in many analyses from 3/16" through 3½". A wide range of chemistries include C-1018, C-1137, C-1117, C-1045 and MCX-1213, plus Ledloy Grades A & B.

PRECISION SHAFTING

Ground, polished and stress relieved in the Pacific mill, constant laboratory inspection during every vital step insures the highest "quality controlled" product... where precision counts. Available through 2 3/16" diameter.

Avail yourself of Pacific Tubes' Engineering Service in solving your metallurgical or application problems.

PACIFIC
TUBE COMPANY
5710 Smithway Street, Los Angeles, California
Phone RAymond 3-1331



"PRESCRIPTIONS" FOR YOUR REFINERY PROBLEMS! ... by TRETOLITE

SALT

TRETOLITE CHEMICAL DESALTERS

Used daily by refiners all over the world ... currently desalting over 1½ million barrels per day, at an average cost of 1.3 mills per barrel, with salt removals in the 95 to 100% range. Tretolite Desalting can be acquired by purchase, rental or owner-built options.

CORROSION

KONTOL CORROSION INHIBITORS

Applicable to practically every refinery system requiring internal corrosion protection. Test coupons, application advice and other specific assistance—as well as the Tretolite research and laboratory facilities—are always available to you.

COPPER CONTAMINATION

KUPLEX METAL DEACTIVATOR

A metal deactivator for refined hydrocarbon products such as gasoline, kerosine, jet fuel, diesel, furnace and turbine oils. Prevents the deterioration of these products caused by metal catalyzed oxidation.

EMULSIFICATION

TRETOLITE CHEMICAL DEMULSIFIERS

For the correction of a wide variety of emulsion problems that plague most refineries: tank bottoms disposal, refinery wastes, various treating procedures. Also available as fuel emulsion preventives, to prevent the emulsification of burning oils and diesel fuels.

Ask the Man in the Red Car

For Further Information on These or Any Other Tretolite Products, ask your Tretolite Refinery Service Man.

AR-57-3

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 Marshall Avenue, St. Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, Calif.

Chemicals and Services for the Petroleum Industry

Desalting • Demulsifying • Corrosion Inhibiting • Scale Prevention • Fuel Oil Additives • Water De-oiling • Metal Deactivators

When the Pressure Is On . . .

. . . for more efficient processing equipment operating at higher pressures and temperatures, experienced fabricating skills are important. This pressure vessel in carbon steel, designed to withstand 300 psi at 270°, is one of many types of vessels Graver fabricates to customer requirements in conformance with the ASME Code. Eminently satisfactory performance and long-life is assured when Graver's century-aged skills are employed. When high pressures and temperatures are involved, it is a sound decision to discuss your requirements with Graver.

GRAVER®

Building for the Future on a Century of Craftsmanship in Steels and Alloys

GRAVER TANK & MFG. CO., INC.
EAST CHICAGO, INDIANA
New York • Philadelphia • Edge Moor, Delaware • Pittsburgh
Detroit • Chicago • Tulsa • Sand Springs, Oklahoma • Houston
New Orleans • Los Angeles • Fontana, California • San Francisco

For more data on advertised products, use Readers' Service Cards, last page.

What happened to the price of oxygen?

The price of bulk oxygen has dropped about 80% in 12 years, while most other prices have risen. Oxygen is now being produced in large quantities for a few dollars per ton.

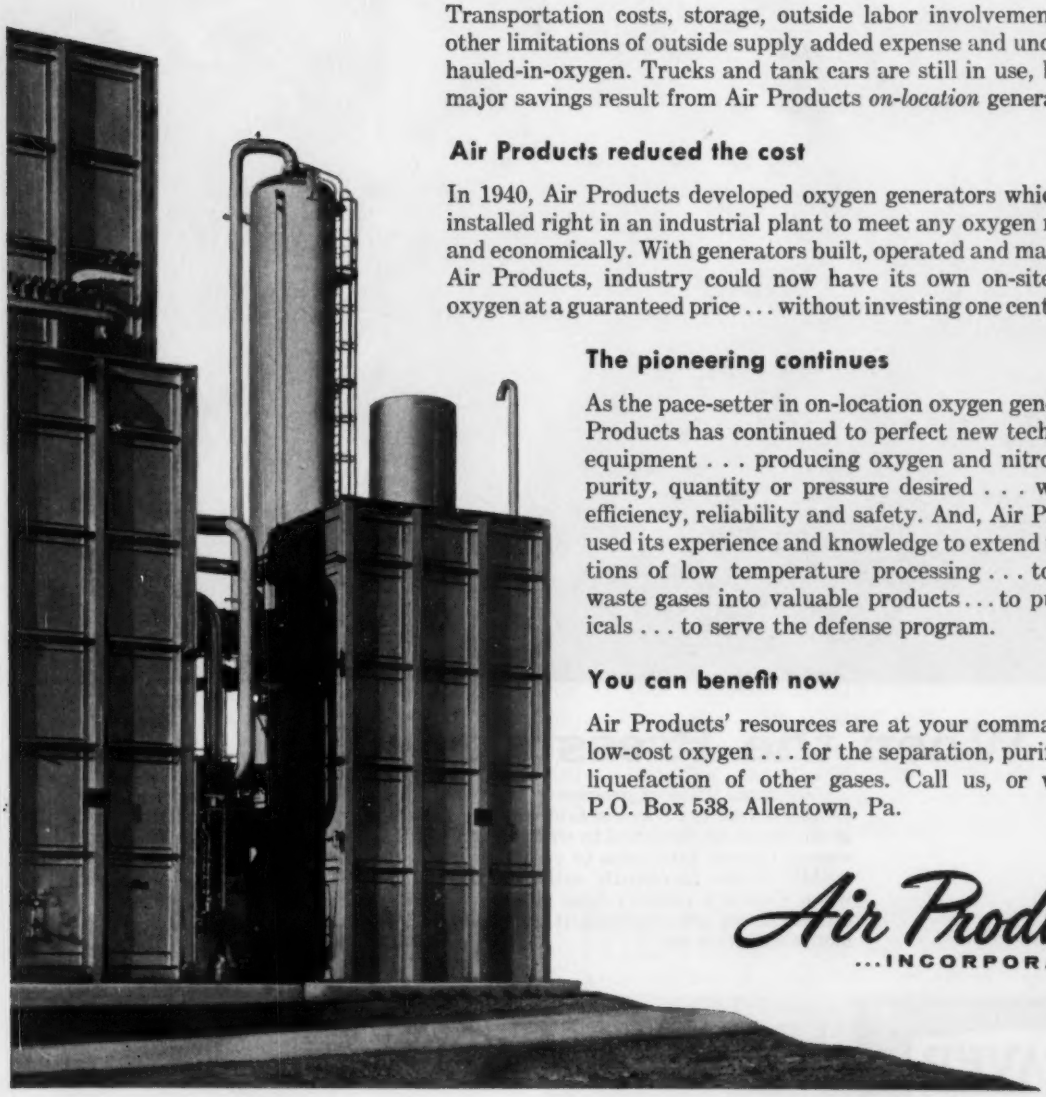
Oxygen isn't the high-priced chemical it used to be. Now, it's a low-priced tonnage commodity—a utility purchased like electricity or water. The price drop is the *real reason* oxygen usage has climbed beyond 70 billion cubic feet per year.

Why was it costly?

Transportation costs, storage, outside labor involvements and the other limitations of outside supply added expense and uncertainty to hauled-in-oxygen. Trucks and tank cars are still in use, but today's major savings result from Air Products *on-location* generation.

Air Products reduced the cost

In 1940, Air Products developed oxygen generators which could be installed right in an industrial plant to meet any oxygen need, safely and economically. With generators built, operated and maintained by Air Products, industry could now have its own on-site supply of oxygen at a guaranteed price . . . without investing one cent of capital.



The pioneering continues

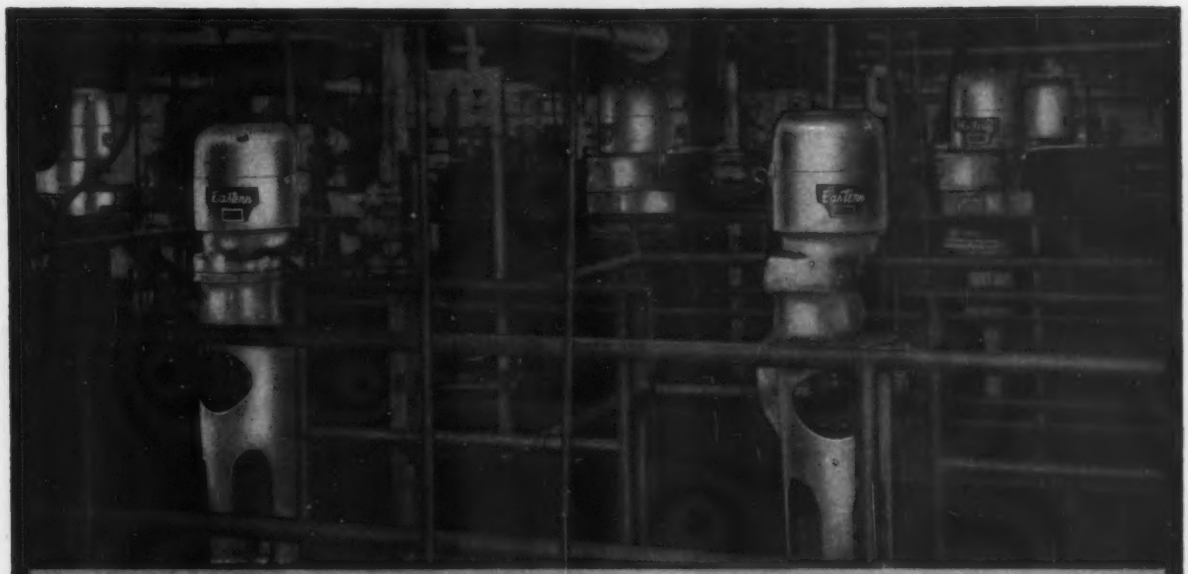
As the pace-setter in on-location oxygen generation, Air Products has continued to perfect new techniques and equipment . . . producing oxygen and nitrogen in any purity, quantity or pressure desired . . . with greater efficiency, reliability and safety. And, Air Products has used its experience and knowledge to extend the applications of low temperature processing . . . to transform waste gases into valuable products . . . to purify chemicals . . . to serve the defense program.

You can benefit now

Air Products' resources are at your command . . . for low-cost oxygen . . . for the separation, purification and liquefaction of other gases. Call us, or write us at P.O. Box 538, Allentown, Pa.

Air Products
...INCORPORATED

Hundreds of Air Products package generators and tonnage plants are now on stream . . . capacities range from ⅛ ton to 500 tons per day.



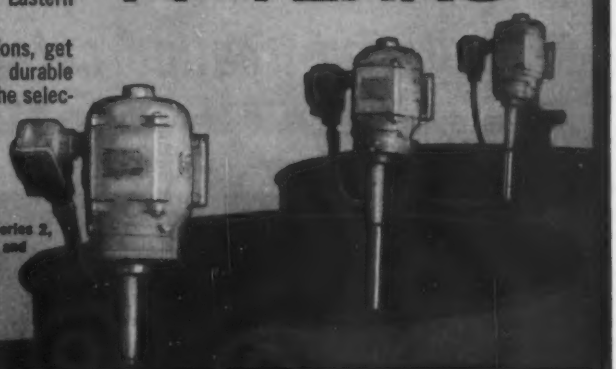
Back in 1942 the new synthetic rubber program was of urgent importance to the war effort. Naugatuck Chemical Co., now a Division of U.S. Rubber Co., developed processes that included fluid mixing applications. Many of Naugatuck's top-entering and portable mixers were engineered and manufactured by Eastern Industries specifically for these processes.

After fourteen years of hard, continuous service, these Eastern Mixers continue proving their built-in **reliability.**

If you have a process entailing critical operating conditions, get a long-term guarantee on your investment by selecting durable Eastern Mixers. Eastern offers engineering assistance in the selection of proper mixers from the complete Eastern line.

CONTINUOUS SERVICE . . .

14 YEARS



Eastern
INDUSTRIES, INC.
Mixer Division
Regent Street
Norwalk, Conn.

Write for Catalog Series 2, containing product and engineering data.

PORTABLE MIXERS

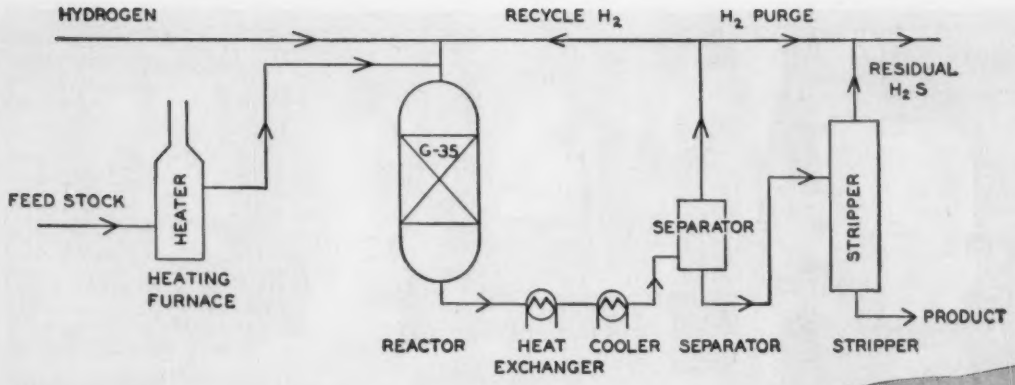
Various models offer a choice of speeds and H.P. dependent upon the consistencies of fluids. All models are available with shafts and propellers of various alloys. Single and dual propellers, and a wide choice of motors give flexibility to handle the most critical of operating conditions.

TOP & SIDE ENTERING MIXERS

Heavy-duty models cover the range from ¼ to 30 H.P., at speeds from 280 to 1725 R.P.M. Versatile in design . . . rugged in performance, these mixers offer a wide choice in mounting arrangements and motors. All side entering models are available with stuffing boxes which can be repacked with a full tank.

TURBINE MIXERS

Many of the Eastern Turbine applications include blending, dissolving and heat transfer. A variety of motor mounts and stuffing boxes available within a H.P. range of ¼ to 40, add flexibility to the Eastern line.



Naphthas, middle distillates, gas oils and lube stocks can all be upgraded by hydrogen treating with the use of new Girdler G-35 catalysts. These highly active cobalt molybdenum catalysts were developed specifically for the desulfurization, denitrification and stabilization of petroleum feedstocks covering a wide molecular weight range. Typical flow diagram is shown.

Check these outstanding benefits of G-35 hydrogen-treating catalysts

G-35 HAS OUTSTANDING PHYSICAL PROPERTIES — these are retained even after extended use. Permit outstanding operational flexibility, continuous economical operation with essentially 100% yields.

IMPROVEMENT OF COLOR stability, lead susceptibility, burning characteristics and the removal of poisons from catalytic reforming feedstocks are among the more important results achieved. Girdler's expanded production facilities are geared to meet your needs for G-35 catalysts.

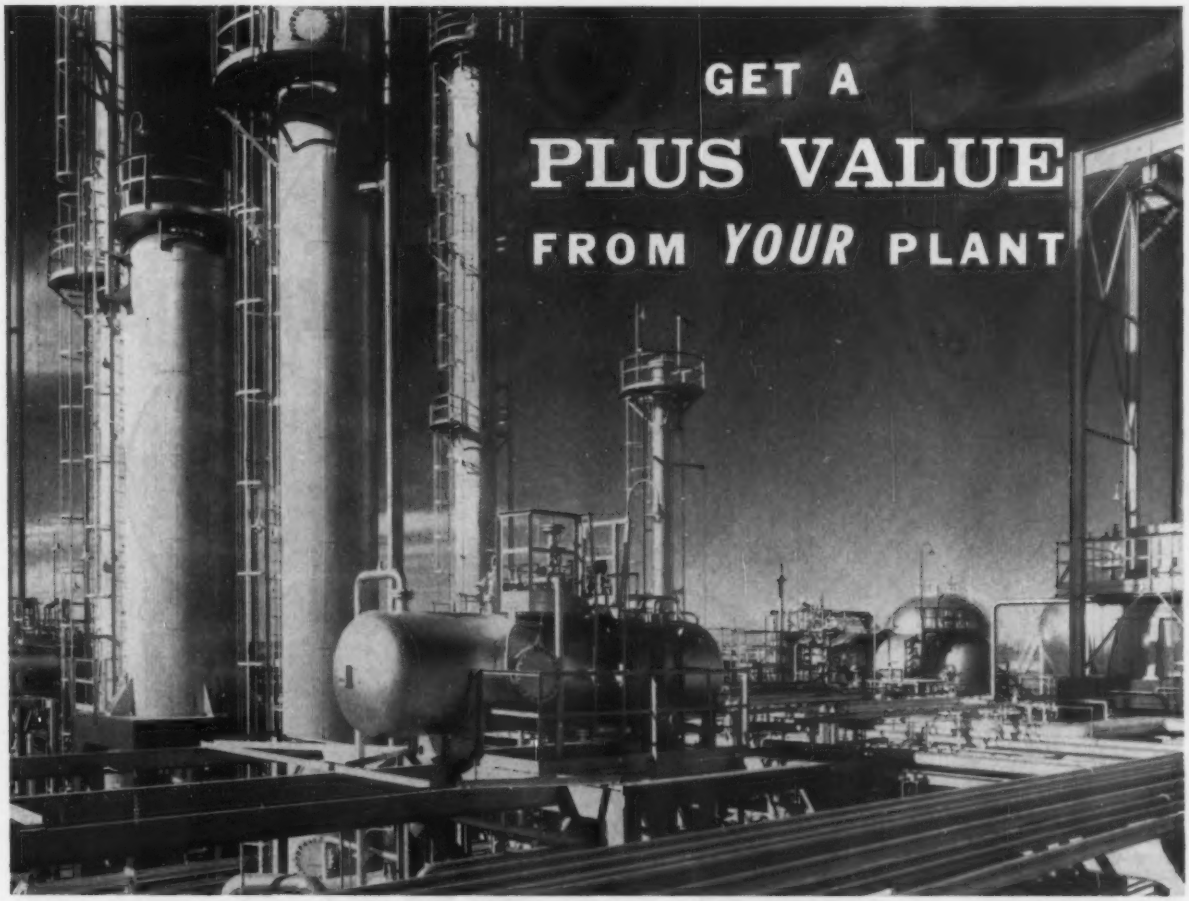
DETAILED INFORMATION is available on G-35 catalysts. Bulletin GC 304 discusses applications, gives process conditions for various distillate stocks, performance features and typical catalyst specifications. Free on request.

CATALYST DEPARTMENT

the GIRDLER Company

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY

GIRDLER MANUFACTURES CATALYSTS FOR: HYDROGENATION • SYNTHESIS GASES AND HYDROGEN GENERATION • DESULFURIZATION • NEW CATALYTIC PROCESSES



You always get a *plus value* in engineering ability and construction skill when your plant is planned and built by The REFINERY ENGINEERING Company. TRECO has never been guided by *minimum* requirements on any job, large or small.

Remember the *plus value* TRECO offers when you plan your next plant.

1942 TRECO 1957
15th ANNIVERSARY

A brochure showing work done by TRECO is available. A copy will be mailed you promptly upon request on your company's letterhead.

A DIVISION of VITRO CORPORATION of AMERICA

The REFINERY ENGINEERING Company

NEW YORK TULSA TORONTO

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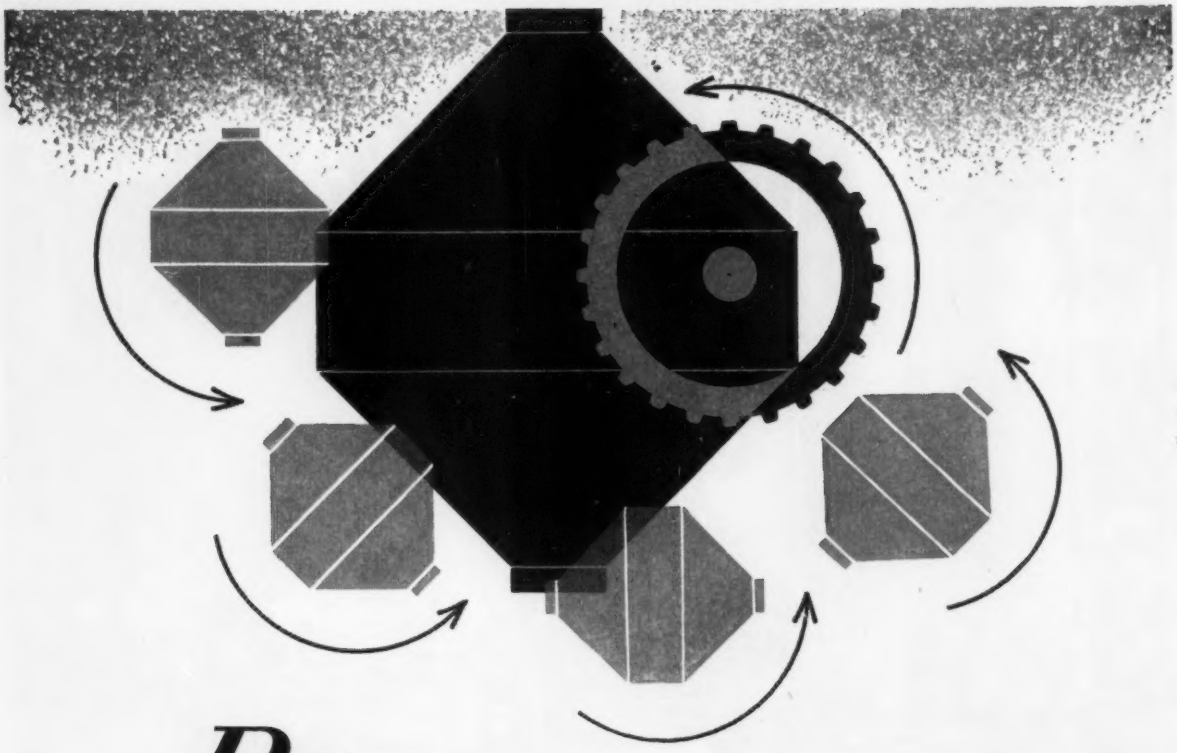
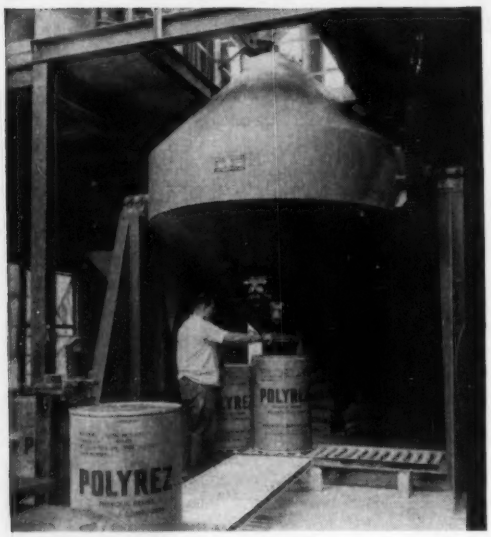


Patterson gives POLYREZ 70% REDUCTION IN BLENDING TIME

with the famous ThoroBlender®



This deep cut in processing time represents for Polyrez Company, Woodbury, New Jersey, the difference between earlier spiral blending of phenolic resins and today's rapid ThoroBlender operation. Previous production difficulties included product caking and loading limitations. Now, very large batches of completely homogeneous blends are obtained in record time with the ThoroBlender, even with additives as small as 2%. For fast, gentle, thorough mixing—independent of flow properties of your material or variations in particle size—put the Patterson ThoroBlender to work in your plant. A Patterson engineer will be glad to arrange for test blending of your materials in our laboratory and discuss the data with you. Write.

ADVANCED PROCESS EQUIPMENT OF ENDURING SATISFACTION

THE Patterson FOUNDRY AND MACHINE COMPANY

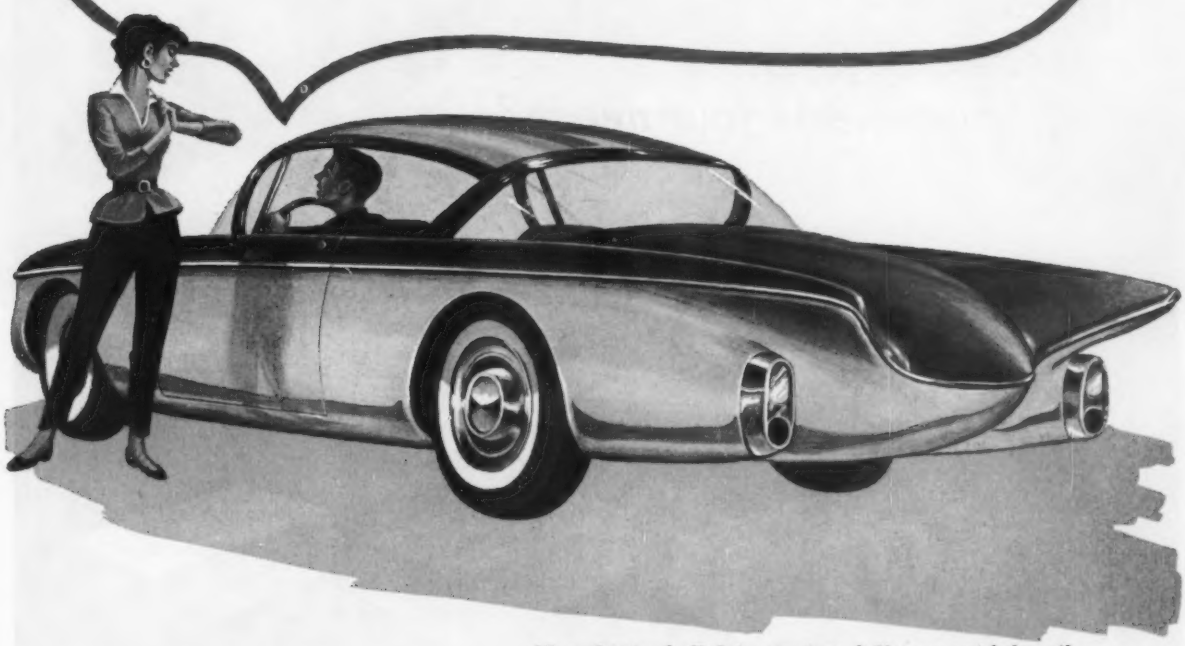
A Subsidiary of Ferro Corporation

East Liverpool, Ohio

THE Patterson FOUNDRY AND MACHINE COMPANY (CANADA) LIMITED

Toronto, Ontario

Nothing succeeds like BARIUM-based detergent additives!



Now 84% of all detergent and dispersant lube-oil additives are based on barium and the percentage is still climbing steadily.

Westvaco has participated in this phenomenal success story by working closely with additive researchers to develop readily soluble barium values suited to their needs.

By pioneering several new forms of barium with important applications outside the petroleum industry we are fully competent to supply your every need for barium chemicals.

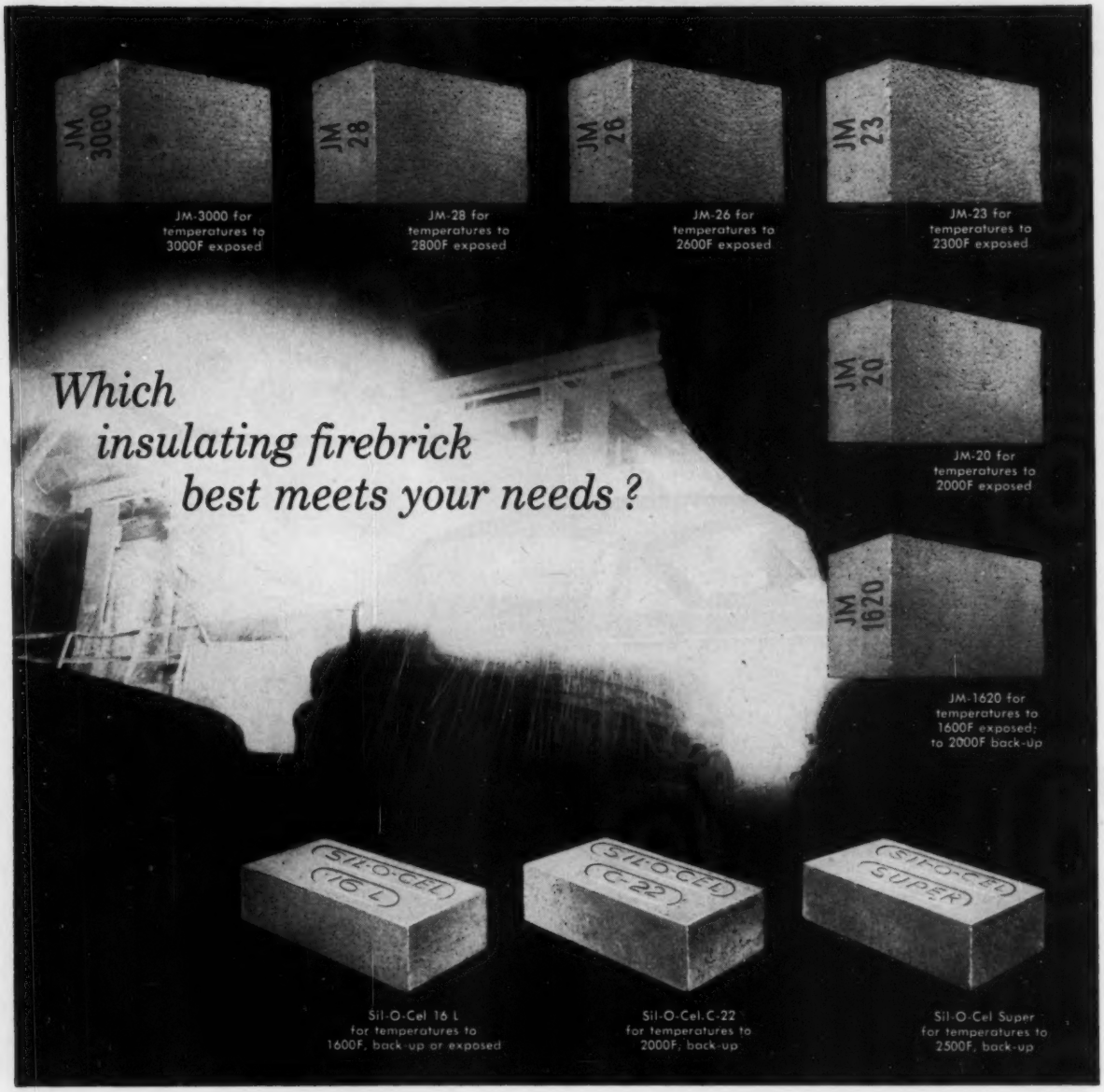
fmc® chemicals

Westvaco Mineral Products Division

FOOD MACHINERY AND CHEMICAL CORPORATION

161 E. 42nd St., New York 17 • Chicago Cincinnati Houston Philadelphia Newark, Calif.

BECCO® peroxygen chemicals • FAIRFIELD® pesticide compounds • FMC® organic chemicals • NIAGARA® insecticides, fungicides and industrial sulphur • OHIO-APEX® plasticizers and resins • WESTVACO® alkalis, solvents, phosphates, barium and magnesium chemicals


JM 3000
JM-3000 for temperatures to 3000F exposed
JM 28
JM-28 for temperatures to 2800F exposed
JM 26
JM-26 for temperatures to 2600F exposed
JM 23
JM-23 for temperatures to 2300F exposed
Which insulating firebrick best meets your needs?
JM 20
JM-20 for temperatures to 2000F exposed
JM 1620
JM-1620 for temperatures to 1600F exposed; to 2000F back-up
SIL-O-CEL 16 L
SIL-O-CEL C-22
SIL-O-CEL SUPER
Sil-O-Cel 16 L for temperatures to 1600F, back-up or exposed
Sil-O-Cel C-22 for temperatures to 2000F, back-up
Sil-O-Cel Super for temperatures to 2500F, back-up

Only Johns-Manville's insulating brick family offers the right combination of properties . . . *for furnace requirements to 3000F!*

J-M's nine *different* insulating firebrick* means you never have to settle for a brick that's nearly right! Instead, you choose the one brick that best meets your needs . . . for such important properties as temperature resistance, load-bearing strength, conductivity and density.

Johns-Manville has two strategically located plants for the production of insulating brick: Lompoc, California, and Zelienople, Pennsylvania. Brick are available from the stocks of authorized Johns-Manville distributors in key industrial areas.

For information on insulating firebrick as well as hydraulic-setting refractories, write for brochures IN-115A and RC-28A to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ont.

**Sil-O-Cel® Super and C-22 insulating brick are for back-up use only*

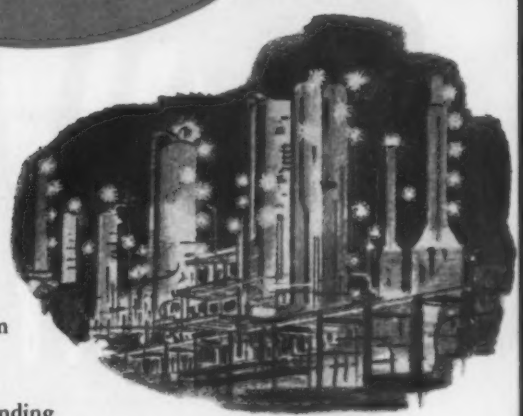
Johns-Manville REFRACTORY AND INSULATING REFRACTORY PRODUCTS

For more data on advertised products, use Readers' Service Cards, last page.

Selectivity

is TRADITIONAL at WESTERN

Selectivity CHARACTERIZES SOLVENT EXTRACTION

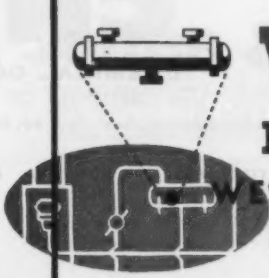


The selective extraction of the aromatic hydrocarbons, Benzene, Toluene, Xylene, or the production of an aromatics-rich concentrate, are the chief functions of the aromatics extraction process — with the concentrates thus obtained destined for use as blending stocks for high octane aviation gasoline, as well as premium and regular grades of motor fuel.

This process permits the production of extremely high octane blending materials without the necessity of operating the catalytic reformer at very high severity while, nevertheless, recycling the low octane components of the catalytic reformate for essentially complete conversion into high octane material.

Selectivity also characterizes the entire manufacturing process of Western heat transfer equipment — from design to fabrication. Western technical and engineering personnel, equipment, materials — all are carefully selected to perform the specific tasks required for the production of heat exchangers of the highest quality and longest service, regardless of the processing demands.

A Western heat transfer specialist is always available to assist in engineering and designing heat exchangers to fit your specific needs.

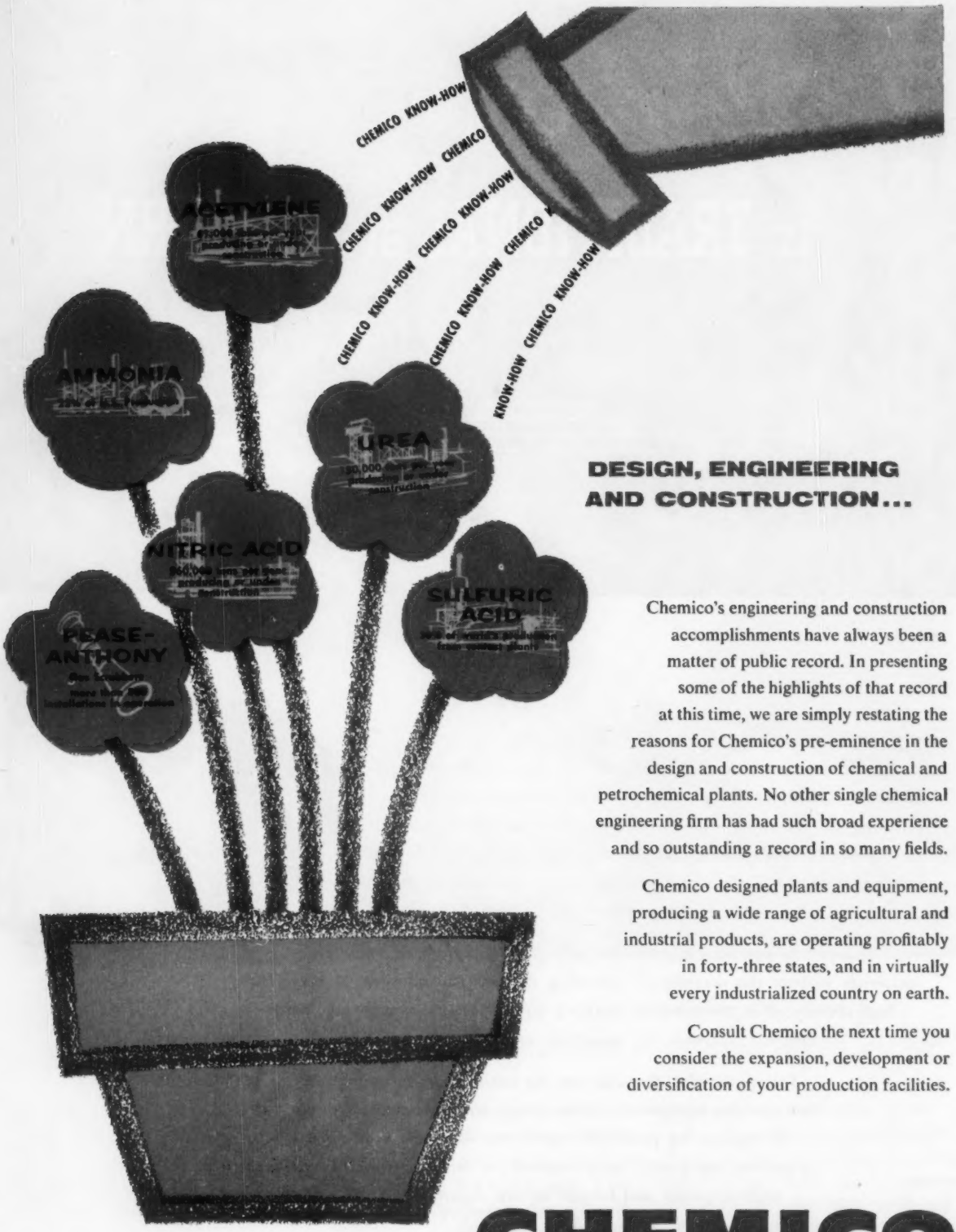


WESTERN

HEAT EXCHANGERS

WESTERN SUPPLY COMPANY

P. O. Box 1888 – Tulsa, Oklahoma



DESIGN, ENGINEERING AND CONSTRUCTION...

Chemico's engineering and construction accomplishments have always been a matter of public record. In presenting some of the highlights of that record at this time, we are simply restating the reasons for Chemico's pre-eminence in the design and construction of chemical and petrochemical plants. No other single chemical engineering firm has had such broad experience and so outstanding a record in so many fields.

Chemico designed plants and equipment, producing a wide range of agricultural and industrial products, are operating profitably in forty-three states, and in virtually every industrialized country on earth.

Consult Chemico the next time you consider the expansion, development or diversification of your production facilities.

CHEMICO

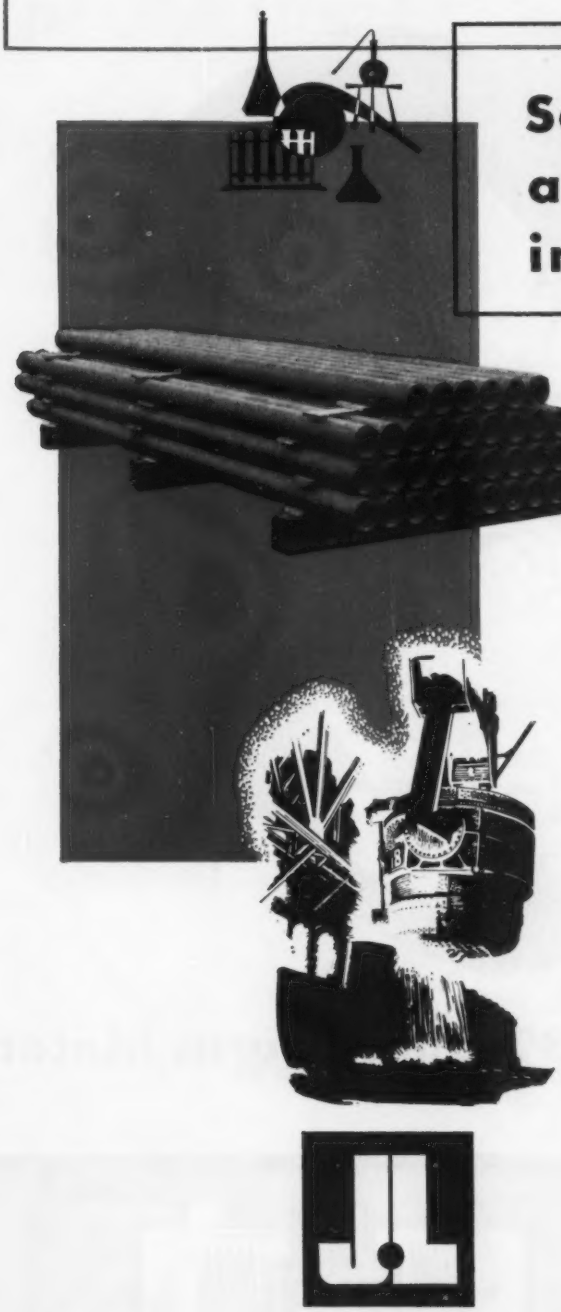
CHEMICAL CONSTRUCTION CORPORATION

A SUBSIDIARY OF ELECTRIC BOND AND SHARE COMPANY

525 West 43rd Street, New York 36, N. Y. • Cable Address: CHEMICONST, New York

CHICAGO • DALLAS • PORTLAND, ORE. • TORONTO • LONDON • PARIS • JOHANNESBURG • TOKYO

Scarcity Accents the Importance of Quality . . .



So You Have an Important Stake in J&L Research

Every man who buys or uses or is interested in the use of A.P.I. Tubular Products can observe the results of J&L research.

It is reflected in the adaptability and useful life expectancy of every length of J&L pipe, seamless or welded.

It is reflected in the excellence of the technical services of J&L Supply Men actively and enthusiastically interested in helping you get maximum dividends from your pipe investments.

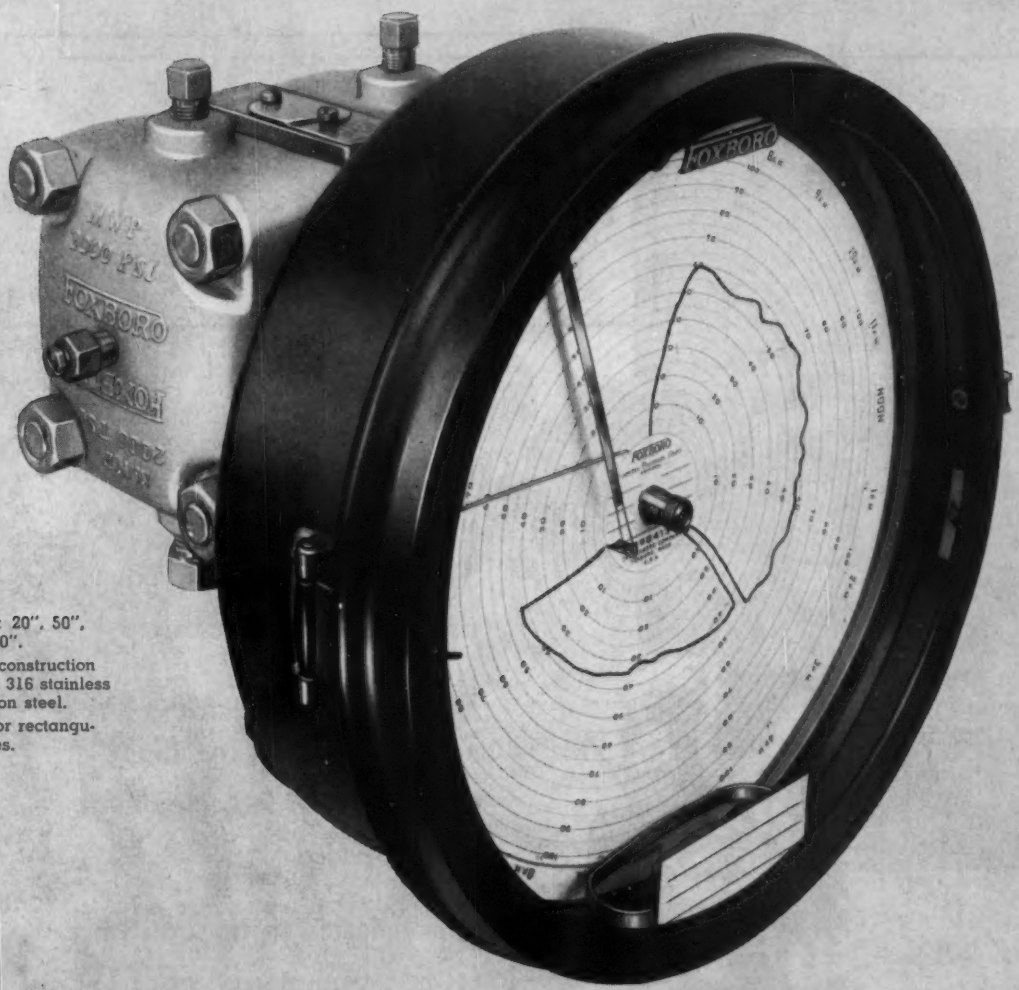
Jones & Laughlin

SUPPLY DIVISION – Tulsa

SERVING THE UNITED STATES AND CANADA

3-1

NOW... a "Dry" Flow Meter with .

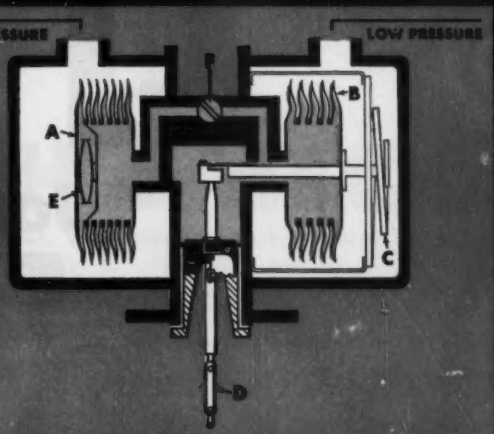


- Ranges: 20", 50", 100", 200".
- Forged construction in Type 316 stainless or carbon steel.
- Round or rectangular cases.

...the new Foxboro Type 37 Diaphragm Meter

How It Works

In schematic drawing at right, areas shown in color represent a stable, non-freezing liquid. Any pressure increase in the high pressure chamber compresses Diaphragm Unit A, displacing its liquid and expanding Diaphragm Unit B until force of Range Spring C equals the difference between the forces on Diaphragm Units A and B. Linear motion of Diaphragm Unit B moves inner end of Drive Bar D — outer end moves correspondingly through the bellows-sealed flexure bar, driving pen arm. Built-in Temperature Compensator (E) proportionately adjusts diaphragm capacity as ambient temperature variations affect volume of filling fluid. External damping adjustment is shown at F.



•complete overrange protection!

•sustained high accuracy!

Now you can have mercuryless flow measurement for a wide range of differential pressures — at static pressures up to 2000 psi — with greater safety and dependability than ever before! The new Foxboro Type 37 Diaphragm Meter not only combines unmatched ruggedness and precision in a dry meter — it's by far the easiest to adjust and maintain. And it does away with zero drift problems, once and for all! Expansible, Type 316 S.S. diaphragm elements respond to changes in pressure with unmatched sensitivity, yet are completely immune to overrange up to full static pressure! A unique packless drive bar precisely transmits linear motion to the pen arm. Range-changing is easy, due to new twin-spiral spring design. Wide range damping is externally adjustable under pressure. And the Type 37 is self-compensating for temperature changes in all differential ranges. Get full details on this high utility, completely dependable dry flow meter. Arrange for a demonstration with your nearby Foxboro Field Engineer, or write

The Foxboro Company, 7411 Norfolk St., Foxboro, Mass., U.S.A.

FOXBORO

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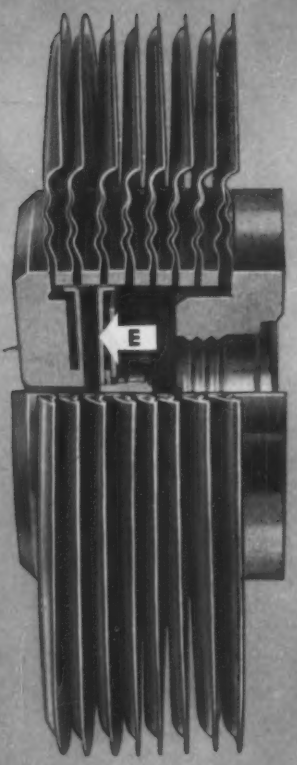
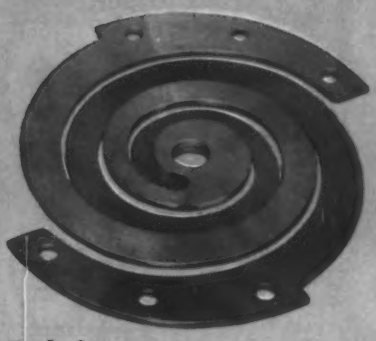
FIRST IN FLOW METERING



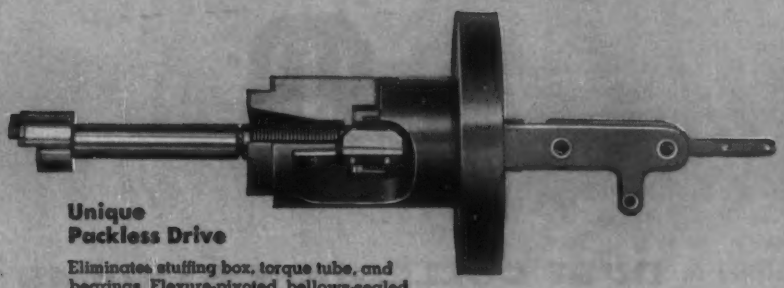
Exclusive Diaphragm Elements

Type 316 S.S. diaphragm units in both high and low pressure chambers provide greatest linearity and freedom from hysteresis; nesting design and integral spacer rings provide safe, positive, overrange protection. Temperature compensation (E) is built into diaphragm assembly . . . never requires change or adjustment.



Exclusive Range Springs

Heavy gauge Ni-Span C alloy, twin-spiral springs provide high sensitivity with lasting accuracy. Readily accessible . . . range changes are easily made, in minutes!

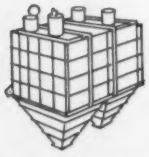


Unique Packless Drive

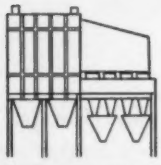
Eliminates stuffing box, torque tube, and bearings. Flexure-pivoted, bellows-sealed drive bar transmits diaphragm's linear motion to the pen arm with unequalled sensitivity *and undiminished power*. Seal for flexure pivot is a tough, flexible bellows.

Pay dirt!
...year after year!

BUELL CYCLONE



"SF" ELECTRIC PRECIPITATOR



PRECIPITATOR-CYCLONE COMBINATION

Buell Cyclone collectors pay off two ways: extra efficiency from the start . . . and extra years of operation, with little if any maintenance. Unique features like Buell's exclusive Shave-off deliver an extra percentage of dust collection efficiency: in nearly all cases, Buell installations pay for themselves in just a few years. And heavy plate construction, scientific proportioning, side entry of dust-laden gases are reasons why they keep on earning for many, many years. For specific details, write for "The Collection and Recovery of Industrial Dusts". Just write Dept. 21-K, Buell Engineering Company, Inc., 123 William St., New York 38, New York.

buell

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

A Quick Look at the Industry THIS MONTH

Small Refiners "Hurt" and "Helped" by Military Set-Aside Changes . . . **"Hurt":** Reductions in military budget effected by 1957 "economy Congress" include reduction in procurement of aviation and other special fuels by about 13 percent, with loss to refiners estimated to be from $115 million to $170 million.

"Helped:" Military supply agency's latest bid invitations included, for the first time, small refiner set asides for Navy special, No. 6 and diesel fuel oils.

Commercial Airlines' multi-million dollar race to build jet airliners will start paying off for refiners in '58, helping to offset some of the military losses. Trans World Airlines reports its Boeing 707 uses about 1800 gallons of kerosine per hour while in the air, nearly 700 gallons per hour while idling on the ground.

Refining Outlook . . . U. S. petroleum demand pattern still isn't going according to Hoyle. Chase Manhattan Bank reports energy use showed only fractional gain in first seven months of '57, compared with same period in '56. This is in sharp contrast to earlier trend estimates that demand would gain four percent per year at least through '57 and '58. September petroleum movement totaled 8.7 million barrels daily, up only 0.5 percent over September '56.

According to BuMines, September gasoline demand showed higher than average seasonal decline from August—fuel oil seasonal increases were less than average. At September's end, products stocks totaled 545 million barrels, up 38 million barrels over a year ago.

There is one bright spot in cloudy oversupply picture: IPAA predicts sharp seasonal boost in U. S. oil product consumption during next three months if weather is normal—possibly 3 to 5 percent higher than year ago levels.

Expected demand increases are posing serious problems for West Coast refiners. Recent Universal Oil Products study reveals average refinery in the area will have to triple hydrogen treating and alkylation, and at least double crude distillation, reforming and cracking facilities by '65 if it is to keep abreast of competition. Expected cost: $40 million.

Catalyst Competition Gains Momentum . . . Lucrative, expanding cat-cracking catalyst market is creating stiff competitive situation among catalyst makers. Latest offering: Kaolin catalysts in pelleted form. Tests have already been made with fluidized form of kaolin for cat-cracking (See PETROLEUM REFINER, May, 1957, Page 213). Pellets will extend range of application for this material.

Refiners Face Automation Problems . . . Refiners looking into complete automation have run up against an unexpected problem. While continuous analyzers and computers make for quick control, sampling techniques on streams are not nearly up to this par. What's needed: A close look at sampling to make sure samples are representative and at right frequency.

Postings on Octane Race . . . Ethyl survey of major U. S. markets shows premium octanes averaged 98.1 for October, 0.1 less than September. Regular averaged 90.9 in October, same as previous month.

In keeping with high quality gasoline requirements of new cars, at least one refinery is upping its percentage of high octane output. When completed, Commerce Oil's new 43,000 barrel per day Jamestown, Rhode Island refinery will gear 60 percent of its production to 100-plus octane gasoline. Usual average is about 45 percent of production. Alkylation, reforming and isomerization will be used to make the high octane product.

New Trends in Lubricants . . . Now lubricants are going thiotropic. This means they act as a thin oil when worked and will return to the consistency of a light grease when working stops. This extends the useful life of the lube. Present use is on business machines, making them operable under severe temperature conditions. Other applications should follow soon.

Quick Look at Washington . . . Much disputed government request to voluntarily cut back oil imports is producing some results—October imports were down more than 100,000 barrels per day from September, and substantial compliance with request is expected by year's end . . . **Crude producers have joined small refiners** in questioning practicality of government oil purchases abroad, particularly 8 million barrel purchase of jet fuel from Puerto Rico and other Caribbean areas—both groups say product could be bought just as cheaply in the U. S., with resulting gains in state and federal taxes from the jet fuel sales . . . **Look for politics-muddled multitudinous government probes** to continue full force in '58—depletion provision will be a major target.

New Trends in Fire Protection . . . Though not generally realized, static electricity is still serious, though only occasional, cause of fires in refineries. Standard Oil (N.J.) reports 18 fires in past 10 years due to static electricity. Tests have shown gaseous carbon dioxide blanketing is effective in preventing explosive vapors in tankage. Additives in minute dosage and radioactive material can also be used. Current safety measures include low pumping rates, avoidance of surface ignition and water, and use of floating roof tanks to eliminate vapor space.

Jersey affiliates are now using specially developed paint for outside of reactors in refineries to detect "hot spots" as they occur in walls of high temperature vessels. Paint is a deep blue when first applied, turns white if temperature rises above 580 degrees.

Chemicals from Gilsonite May Be Next . . . American Gilsonite Co. may soon be selling ammonia at its $18 million Fruita, Colo., high octane gasoline-from-gilsonite plant. Present product output: 1300 barrels of gasoline and 275 tons of electrode-grade coke per day from 650 tons gilsonite.

Refinery is now producing about 3 tons ammonia per day from hydrogenation stage, not enough to market. However, when refinery facilities are expanded—and plans are definitely in the mill—commercial quantities of ammonia may be expected. Other gilsonite chemicals are also being studied.

New Chores for Jet Engines . . . In the near future, jet engines are expected to be "prime movers" of industry, as well as means to change energy from nuclear reactors to usable electric energy. Jets are now being used for electric power generation.

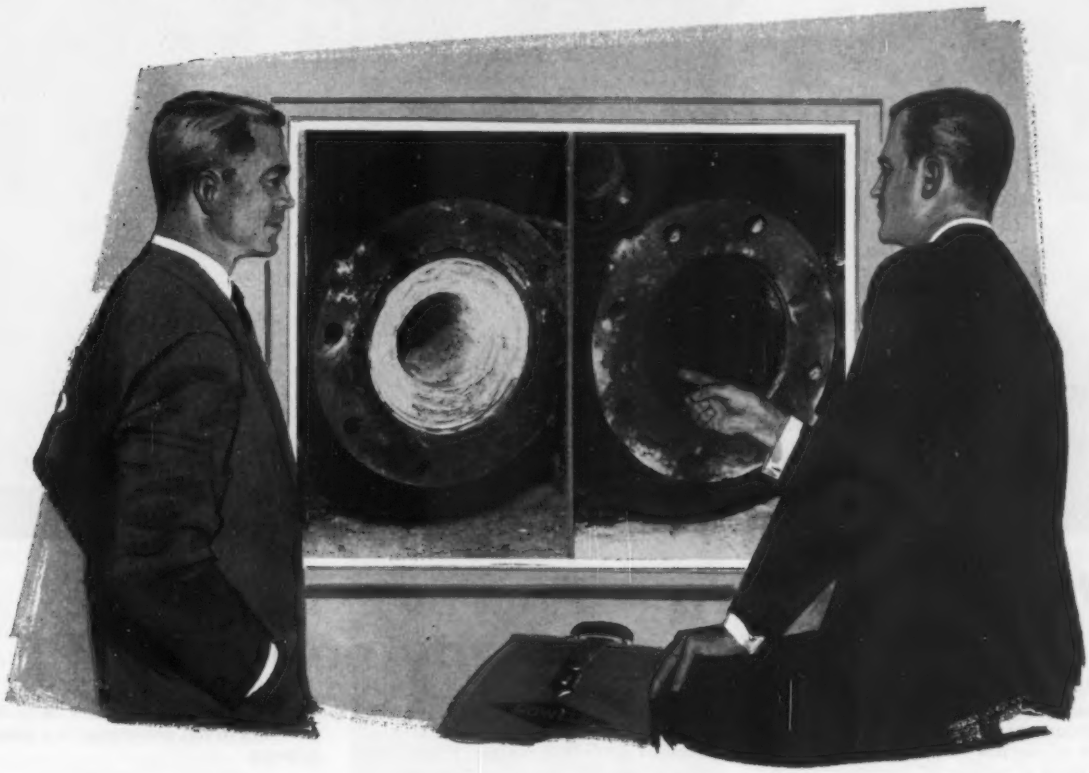
Nuclear Tankers Are Several Years Away . . . Discount talk that nuclear powered merchant ships are just around the corner. Though technical feasibility has been established, it's very unlikely they will be commercially competitive within the next 10 years. Optimum speeds for nuclear tankers will not greatly exceed optimum speeds for conventional tankers.

Germans May Revive Fischer Tropsch Process . . . German chemical industry is faced with same rising cost of raw materials that confront U. S. producers. Coal and coke have risen sharply in cost since the war and now even oil is being priced out of reason. Result: German scientists are studying possibility of reviving Fischer Tropsch process which helped them become one of the world's leaders in production of chemicals and fuels prior to World War II.

Process recovers carbon monoxide from carbide production and iron smelting to provide raw material in making chemicals. One German scientist says manufacture of aliphatic hydrocarbons from recovered carbon monoxide is not only possible, it is economically feasible.

New Fields Show Promise . . . The 88 new oil field discoveries completed in September included the second deepest producer in the world and other strikes of significance. The deep one was drilled in Plaquemines Parish, South Louisiana, by Richardson & Bass and it tested 860 barrels of 40-gravity crude a day. Others were: Phillips' discovery in Ochiltree County, Texas Panhandle, gaging 800 barrels of 41-gravity; and Atlantic's find in Roosevelt County, New Mexico, good for 360 barrels of 47-gravity oil daily.

here's how Dowell chemical cleaning saved $71,000 and helped protect a plant profit!



A few months before their peak season, the operators of this plant decided their main water line might not supply the water necessary to meet peak demands. The line was cast-iron, 16-inches in diameter and over 7,000 feet long. Its original flow efficiency or "C" factor had been 105; scale build-up had reduced this to 72. To lay an auxiliary line would cost at least $85,000.

Dowell contracted to clean the pipe chemically for a little less than $14,000, and to restore a minimum of 50 per cent of the line's lost capacity.

This Dowell did, and more—increasing the "C" factor to 92! Enough water was immediately available for capacity operation. This saved the plant $71,000 and helped protect the company's annual profit.

The operating credit realized by this food processing plant, as a result of Dowell service, is similar to those realized by other Dowell customers—in the steel, paper, chemical, oil refining, power and allied industries.

Dowell engineers are experts in the use of solvents to remove scale and sludge—deposits that cut the throughput of product, process and steam generating systems. Dowell does the job, furnishing all chemicals, trained personnel, pumping and control equipment.

For specific information on how chemical cleaning can help you to greater profits, call the Dowell office nearest you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

25 years forward

Have Dowell clean it chemically DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

How Suntide Refining blends products in tanks holding up to 200,000 barrels

Some of the largest tanks ever mixed can be found at Suntide Refining Company's plant in Corpus Christi, Texas. Suntide performs a variety of blending operations in these tanks—equipped in some cases with *five* LIGHTNIN Mixers.

Many of these LIGHTNINS have been in service for four years, blending a wide variety of products: diesel oil, crude, jet fuel, and leaded gasoline. Suntide reports that the mixers have operated continually during that time *without a single failure* of any part including the mechanical seals.

Low-cost maintenance

A mechanical seal, optional equipment on any new LIGHTNIN Side Entering Mixer, is one feature of the mixers installed at Suntide Refining. It can save refiners thousands of dollars per year on big tank mixer maintenance.

The LIGHTNIN Mechanical Seal Mixer eliminates stuffing box repacking, and *never* needs shaft seal adjustment. And the seal can be replaced in a few minutes —even under a full head of liquid in the tank—without dismantling or removing the mixer from the tank!

Exact mixing results

Not all tanks require five large side entering mixers, of course. In many cases, only one LIGHTNIN will blend products to full uniformity in a matter of minutes.

Your LIGHTNIN representative can tell you exactly what mixing action is required to do the job at your refinery. His recommendations are based on data accumulated over many years of Mixco research.

Get just-right mixing in all of your tanks—big or small—by installing LIGHTNIN Mixers. For more information, contact your nearest LIGHTNIN Mixer representative (he's listed in Composite Catalog). Or write us direct.

"These mixers have been running since October 1953, without a single failure of any part including the mechanical seals," says transfer foreman Ray B. Dunn. He's referring to the LIGHTNIN Mixers installed at Suntide Refining Company's Corpus Christi plant.

Lightnin® Mixers

MIXCO fluid mixing specialists

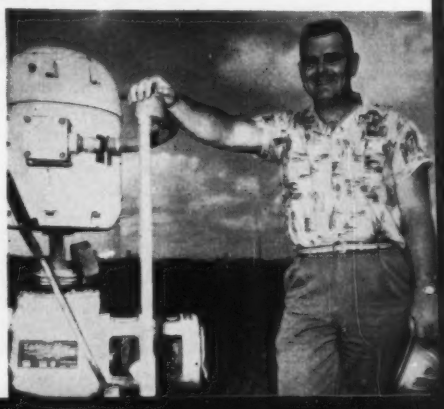
FOR LATEST MIXING INFORMATION and full description of LIGHTNIN Mixers, send for these helpful bulletins:

- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ LIGHTNIN Rotary Mechanical Seals for extra low cost mixing
- ☐ LIGHTNIN Mixers for controlling B.S.V.W. (B-503)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Data sheet for figuring mixer requirements (B-107)

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 164-m Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ont.



RAY L. DUDLEY—1891-1957

RAY L. DUDLEY, internationally known pioneer oil publisher, who headed the largest petroleum industry publishing house and the largest printing company in the Southwest, died at his home in Houston on the afternoon of Tuesday, October 29.

President of Gulf Publishing Company, Mr. Dudley was the founder and publisher of WORLD OIL, PETROLEUM REFINER, and PIPE LINE INDUSTRY magazines, as well as Composite Catalogs for three branches of the oil industry. He also was chairman of the board of Gulf Printing Company.

Mr. Dudley's editorial activity, which for a lifetime spearheaded growth of the company's oil periodicals and brought them international recognition and respect, very definitely puts his name alongside those of other greats in the business journalism field. His own dynamic personality, his zeal for accurate and forceful reporting, and his burning desire to improve not only the publications but the oil industry in general—all these are reflected in the editorial pages published under his direction over a full 40-year span. And they will continue to be an inspiration to the organizations he built.

Mr. Dudley's zeal for dependability and perfection permeated Gulf Publishing offices and personnel, and is chiefly responsible for the companies' growth into one of the nation's leading publishing and printing firms. He inspired and supervised this growth and it was with great satisfaction in his later years that he saw them recognized as most successful, going organizations with a future even more resplendent than the successes he himself had witnessed.

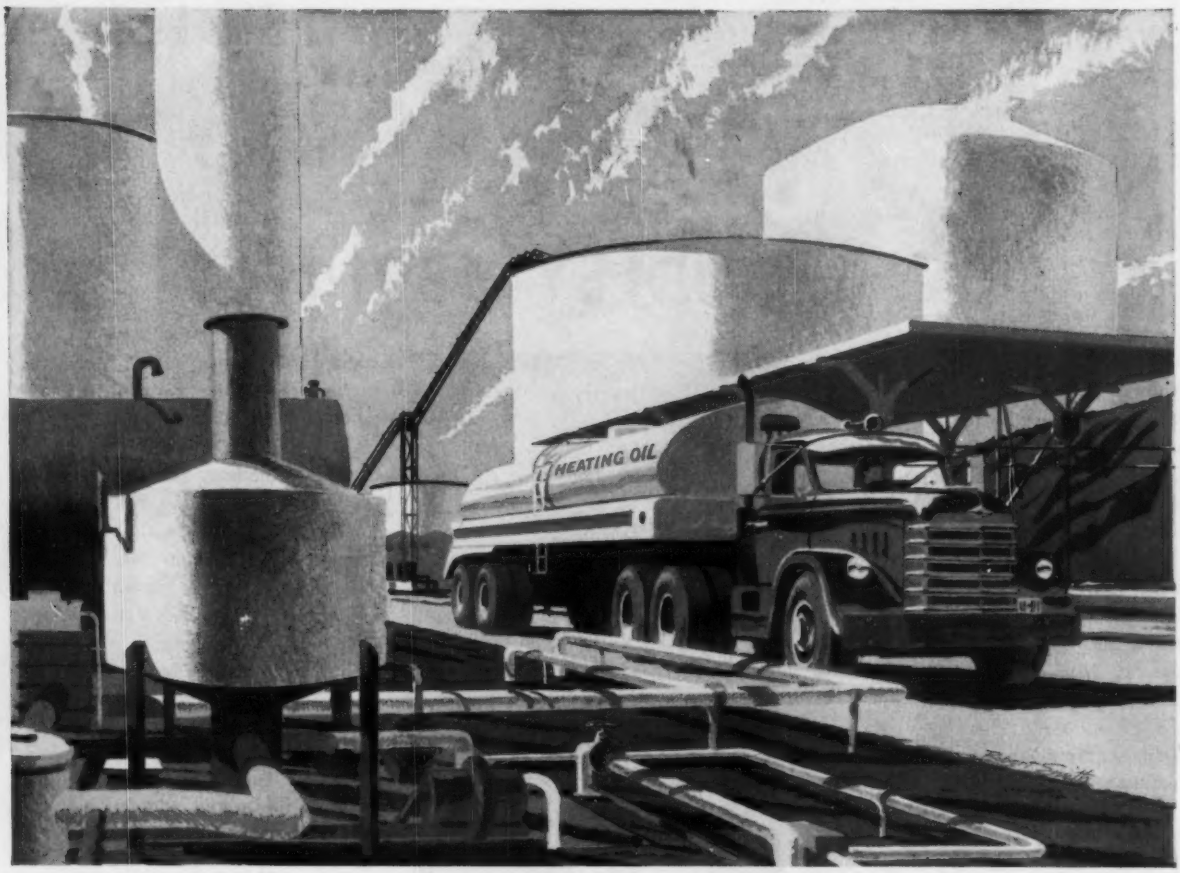
From his earliest days as a newspaper reporter, Mr. Dudley displayed a fearlessness that is the hallmark of a courageous individual. He did his own thinking and was outspoken with his opinions. His vocational niche and a worldwide acquaintance with petroleum leaders made him for years a spokesman for the industry. Here he functioned with utter frankness and candor, no punches being pulled either in his editorials nor in vocal discussions. He was an excellent writer and speaker whose words always carried weight. His was a colorful, picturesque career covering a period when the oil industry was growing up; so it is not unlikely that he will become something of an oil industry tradition whose name will be linked for years to come with events and anecdotes relating to oil. Truly he made a name for himself and his publications in the industry.

Enthusiasm was another word for Ray Dudley. His heart, as his friends know, faltered on several occasions during the past decade and various other ailments slowed him down physically. But he never lost his desire to be up and about and doing things. His co-workers will recall many occasions in recent years when he was so fatigued that another step appeared improbable. Then some mention would be made of an idea for one of the magazines and the RLD mind would spark into action. His face would light up on such occasions and he'd launch out into an enthusiastic discussion of how the problem could be solved or the idea effectuated.

Mr. Dudley was never able, because of his intense interest in the affairs of the industry which his company served, to "let the other fellow do it" completely. Right down to the wire—Tuesday morning, in fact—he was at the office conferring with some of the editors regarding a magazine feature for use during oil's centennial year, 1959. Typically, he was always looking forward, ever planning, ever changing, never quite satisfied that today's product couldn't be improved by tomorrow.

"Is it good for the oil industry?" was the yardstick which Ray Dudley made somewhat official in Gulf Publishing Company offices. He was a worthy champion of the petroleum industry in all its branches and he devoted his talent to the end that Gulf Publications always would continue to strive to be effective and useful in that role.

For several years one of Mr. Dudley's chief concerns was the orderly growth, present and future, of the business institutions which he founded. Years ago



Want more heating oil sales?

Then try this formula... FUEL OIL + FOA-2 = sludge-free systems, consumer satisfaction

Really satisfied fuel oil customers—industrial or home-heat—are those whose heating systems function efficiently month in, month out. No costly downtime for tank entry to clean out sludge for industrial users. No clogging of the system, no additive-caused ash deposits to hamper electrical controls for consumers large or small.

Du Pont Fuel Oil Additive No. 2 minimizes these difficulties—even cleans out systems already near the fouling point because of sludge. FOA-2 disperses sludge in fuel oil, holds tiny particles in fine suspension and prevents sludge accumulation.

FOA-2 is ashless

FOA-2 being a nonmetallic additive, burns completely, leaving no ash to interfere with the operation of ignition and stack controls. Because of this, it does not contribute to chimney deposits and the possibility of puff-backs.

For best results, Du Pont FOA-2 should be added to freshly prepared stocks at the refinery. Small amounts are enough to protect most stocks from sludge . . . insure cleaner burning . . . prevent nozzle and filter fouling . . . and *keep* the burner system clean.

In this way FOA-2 keeps burners *burning*, keeps customers satisfied.

New FOA-2 booklet

Write for a copy of our new booklet on FOA-2 just off the press. It is amply illustrated and gives information about physical properties, applications, performance data and methods of addition.

DU PONT
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Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & CO. (INC.) • Petroleum Chemicals Division • Wilmington 98, Delaware

he set up an Advisory Committee comprising other GPC officials and department heads which has helped with major decisions as to policy and action. This Committee, with its firm grasp of company affairs, will continue to function, thanks to this concrete planning. Therefore no significant change by reason of the president's death is foreseen in company or publication policies.

Ray Lofton Dudley, school teacher, newspaper reporter and executive, editor, founder and head of two large business houses, was born in Denton County, Texas, August 8, 1891. His first oil industry connection came in 1916 with "Gulf Coast Oil News." This periodical, which became "The Oil Weekly" and then in 1947, WORLD OIL, was the principal factor in Gulf Publishing Company's early growth. Mr. Dudley originated the company's successful policy of specialization in 1922 when he founded PETROLEUM REFINER. Five years later the first of three Composite Catalogs appeared. In 1954 when PIPE LINE INDUSTRY was started, that branch of the industry became the third served with a specialized GPC publication.

The three publications bearing Founder Dudley's mark now have a total monthly circulation of approximately 50,000 copies. The *Composite Catalog of Oil Field Equipment* which appears in three volumes totaling more than 5000 pages, is sent all over the world as is the *Refinery Catalog,* now in its 24th year. The *Pipe Line Composite Catalog* was issued for the first time in August, 1957.

Mr. Dudley was a past director of the API, a past director of the Texas Mid-Continent Oil & Gas Association and was one of the founders and past president and national regent of NOMADS. In addition, the list of his civic activities and achievements in Houston and Texas is long and distinguished.

Mr. Dudley is survived by his wife, Frederica Gross Dudley, a son, William G. Dudley of Houston, and a daughter, Mrs. John E. Cashman of Beaumont. Two of the Dudley sons died in the service during World War II.

Fuel Oil Stocks Need Trimming

IF REFINERS CONTINUE to hold crude runs to stills to recent lowered levels, some improvement in the heavy inventories of distillate fuel oil can be realized without adding seriously to motor fuel stocks.

During recent weeks demand still lagged, but refiners cut back operations. Crude runs to refinery stills during the four weeks ended October 25 averaged a little less than 7.8 million barrels a day. This cut-back showed up in slackening of inventory build-up.

In this four-week period, gasoline stocks grew by only 1.8 million barrels, much less than previous rates. However, on October 25, stocks of this product topped those held a year earlier by 7.3 million barrels, and last year's supplies were excessive. Additional such steps are needed this winter.

During the same four weeks, distillate fuel inventory growth was limited to 5.7 million barrels—substantial, but considerably under previous rates. By October 25, these supplies had grown to the all-time high of 175 million barrels, 17.7 million more than was in tanks a year earlier.

Latest API statistical data show how lowered refinery activity can affect product stocks. During the week of October 25, refinery crude runs were cut to 7.6 million barrels a day, about 200,000 barrels a day less than immediately previous rates. At that level, gasoline stocks stood still and distillate build-up slowed considerably. This was encouraging.

"United We Stand . . ."

OIL INDUSTRY RESEARCH stands on the threshold of a great error—or era. The two courses:

Course #1—the Great Error. Each company can go its separate way. When pieces of basic knowledge vital to the success of a non-competitive project are needed they can make their own observations, taking the expensive chance of duplicating the detail already done by another company. Individual company research groups are constantly facing the need for some of the same pieces of information. Therefore, we believe the entire oil industry would benefit from . . .

Course #2—the Great Era. Oil companies can pool their efforts to have fundamental, non-competitive work done in one place fitted up with the requisite tools for performance and review to insure faith in the accuracy and validity of the findings.

This is the purpose of the API Fundamental Research Program.

In manufacturing alone, refiners are using hydrocarbon antiknock data disseminated from API research. Physical instruments are calibrated with pure reference materials from API research. When refiners need to prepare pure reference materials in their own laboratories, they consult first the methods for pure synthesis and purification which have been perfected by API research. And these are but a few examples.

There is no short cut to such information. But, the beauty of it is, it need be obtained only once—if it is developed through a cooperative program such as API.

Which will it be—a great error, or a great era?

Methods for making a new antiknock compound are investigated by an Ethyl research chemist.

How Ethyl Chemical Research Advances Antiknock Technology

Break-throughs in Organo-Metallic Chemistry Point to More Effective Antiknock Agents and New Tetraethyllead Production Methods

EVER SINCE the discovery of tetraethyllead as the first practical antiknock additive, Ethyl scientists have been searching for even more effective and economical antiknock agents.

Extensive research on both organic and metal-organic materials in our Detroit Research Laboratories has shown that the metals are the most promising. Our research also has shown that these materials promise important new advances in tetraethyllead production methods.

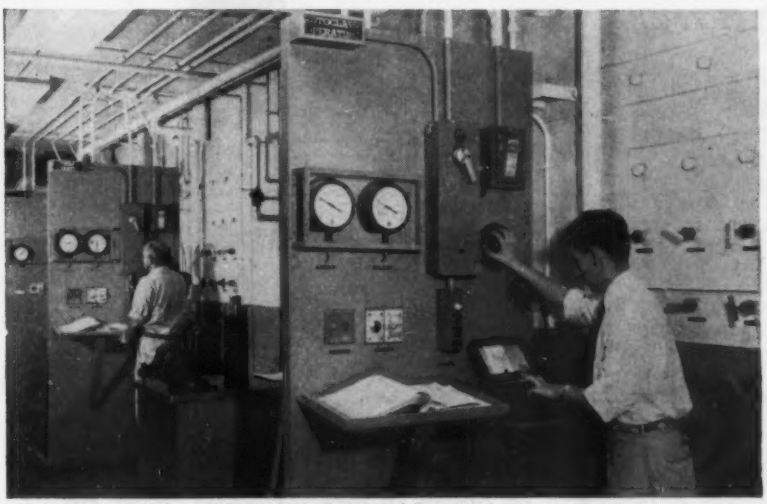
Our efforts to learn more about organo-metallic compounds also have enabled us to make significant contributions to chemical knowledge outside the antiknock field. Ethyl's continuing publication of such information contributes to the expansion of knowledge in this field of chemistry.

Developments in Organo-Metallic Chemistry Offer Antiknock Promise

Much of the early work on metallic antiknocks was hindered by the lack of compounds with solubility, volatility, and stability characteristics suitable for use in gasoline.

Recent break-throughs in chemical knowledge, which were used to good advantage by Ethyl scientists, have indicated that a wide variety of metals might be incorporated in organic compounds. The synthesis of organo-metallic compounds with suitable physical characteristics has enabled us to consider a number of them as antiknock possibilities.

One organic manganese compound, which we call AK-33X, shows definite promise of increasing the power output of piston aircraft engines, when AK-33X is used as a supplement to tetraethyllead. Extensive tests now are being made to determine its effectiveness for automotive use both as a supplement to tetraethyllead and as a primary antiknock.



High-pressure autoclaves in Ethyl's Baton Rogue and Detroit Laboratories are used to run organo-metallic reactions at high pressure and temperatures.

Tetraethyllead Is Synthesized From Common Lead Compounds

Another recent accomplishment of Ethyl's organo-metallic research is a new method of synthesizing tetraethyllead from a wide range of organo-metallic compounds by reacting them with common lead compounds such as lead oxide, lead sulfide, and lead dioxide. This radical departure from present technology circumvents the use of sodium and chlorine.

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An added benefit of the synthesis of tetraethyllead and other organo-metallic compounds is the development in our laboratory of improved techniques for manufacturing triethyl aluminum. This compound is of high interest as a possible new route to the manufacture of tetraethyllead.

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In so far as possible, data on all Ethyl's current research projects in antiknock technology and organo-metallic research will be made available to the Oil Industry.

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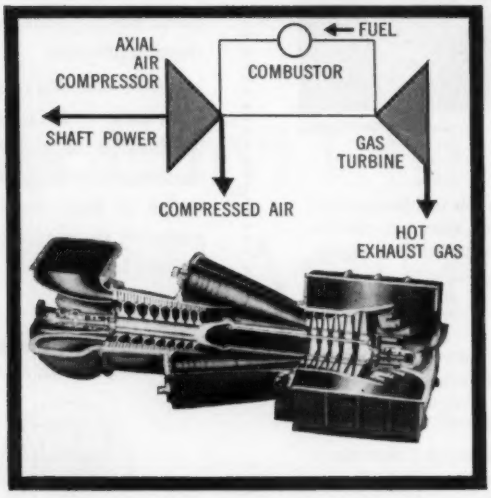

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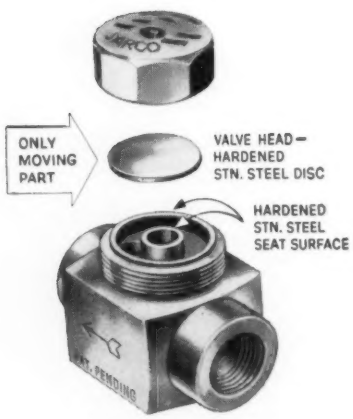

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SARCO Thermo-Dynamic TRADE MARK STEAM TRAP

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OUR INDUSTRIAL ADVISORS for the 1957 Petrochemical Issue are shown above, left to right: Robert L. Bateman, Union Carbide Chemicals Company; Harry L. Fisher, Ocean Minerals Company; Foster Dee Snell, Foster D. Snell, Inc.; Cyrus Thomas, Enjay Company; Lewis F. Hatch, The University of Texas; Kenneth Van Arnum, Oronite Chemical Company; Gordon Brown, Bakelite Company; Robert I. Stirton, Oronite Chemical Company; J. F. Abere, Minnesota Mining & Manufacturing Company, and Melvin Goldberg, Pesticides Advisory Service. These experts pointed out important developments and guided us in our search for material included in this issue.*

Foreword

'57 PETROCHEMICAL HANDBOOK

THIS FIFTH ANNUAL PETROCHEMICAL ISSUE is another step in PETROLEUM REFINER's complete coverage of petrochemicals. Again we are presenting the most complete and up-to-date Handbook to petrochemical processes available anywhere today. In making this Handbook a "valuable working tool" several processes for making each petrochemical are presented. Because of this, the reader can make quick appraisal of the differences between each process. Therefore, the Handbook will improve with age.

Petrochemical production will pass the 40 billion-pound level in 1957. That's up more than 3 percent over 1956, and this year's production will be more than 18 percent greater than the boom year of 1955. This year's production will be valued in excess of $4.75 billion, an increase of more than 4 percent over 1956. This is more than 54 percent of the value of the total chemical production. While petrochemicals take more than half of the business they account for about 26 percent of the total production. And still this requires approximately 2 percent of the total petroleum and natural gas production.

Since petrochemicals are doubling every five years, some really expanded growth is expected during the next 10 years. By 1967 petrochemical production will exceed 160 billion pounds annually. Assuming the price of petrochemicals remains the same, 1967 production will be valued at more than $20 billion.

In order to maintain this expansion trend, capital expenditures for new plants must continue. PETROLEUM REFINER's market research department predicts that in 1958 the petrochemical industry will spend $850 million for expansion in the U. S. Overseas, planned capital investment for petrochemical plants will be $605 million in 1958. This is 20 percent above 1957 for the U. S. and 30 percent increase for foreign plants. This compares with refinery expansion for the same period of $960 million in the U. S. and $1375 million overseas.

Aliphatic petrochemicals, including such tonnage items as ethylene glycol, ethyl alcohol, vinyl chloride, methanol, isopropanol and butanol, still continue to dominate the field. About 86 percent of all aliphatic chemical production is petrochemically derived.

Aromatic petrochemicals do not enjoy this dominance. Competition from coal and coke by-products keeps petrochemical aromatics down to about 4 billion pounds, or one-half of the total aromatic chemical production.

Inorganic petrochemicals, due to the highly competitive ammonia situation, remain unchanged. However, inorganic petrochemicals account for more than 10 billion pounds annual production.

Problems facing the petrochemical industry are (1) higher raw material costs, (2) increased construction cost of new equipment, (3) rising labor rates, and (4) increasing transportation charges. All this with only about 5 percent increase in selling price.

To offset these increased costs, the petrochemical industry is banking heavily on research. To continue the expansion trend, the industry is currently expanding about 4 percent of total sales income for research. New developments and new products based on older petrochemicals are necessary to follow the same growth curve of the past decade. New chemical structures of petrochemical origin will help maintain the growth level above the over-all chemical industry and of all industry in general.

* The attendance by executives, engineers, superintendents or other employes of oil companies at these conferences does not constitute an endorsement of PETROLEUM REFINER over any other publication. The fact that men of outstanding ability are allowed to attend these planning conferences shows the interest which companies have in sound editorial content for the benefit of the industry.

PETROCHEMICAL HANDBOOK INDEXES

Petrochemicals . . . The Boom Continues!

197 **A Look at the Industry** *by Robert L. Bateman*
198 **Functional Fluids** *by Robert I. Stirton*
199 **Aromatic Hydrocarbons** *by J. J. O'Connell*
200 **Pesticides** *by Melvin Goldberg*
201 **Olefins** *by C. H. Thomas*
202 **Plastics** *by Gordon Brown*
203 **Fluorochemicals** *by J. F. Farrell*
203 **Synthetic Rubber** *by Harry L. Fisher*
204 **Synthetic Fibers** *by Frank J. Soday*
205 **Synthetic Detergents** *by Foster Dee Snell*

PROCESS SECTION

ACETALDEHYDE 206
Acetaldehyde 232-233
Acetaldehyde 249
Acetaldehyde monoperacetate 270
Acetic Acid 232-233
Acetic Anhydride 232-233
Acetone 232-233
Acetone 250
Acetone 264
Acetone 272-273
Acetophenone 272-273
ACETYLENE (BASF) 207
ACETYLENE (Wulff) 208
Acrolein 250
ACRYLONITRILE 209
ALKYL ARYL SULFONATES 210
Allyl Alcohol 250
Allyl Chloride 252-253
AMMONIA 211
AMMONIA (Claude) 212
AMMONIA 213
AMMONIA 214
AMMONIA 215
AMMONIA (Uhde) 216
AMMONIUM NITRATE 217
AMMONIUM NITRATE (Stengel Process) 218
AMMONIUM SULFATE 219
AMYL ALCOHOL 220
Amyl Chloride 220
ANILINE FROM NITROBENZENE 221

BISPHENOL A 222
BUTADIENE from BUTANE 223
BUTADIENE from BUTENES 224
iso-Butyl Alcohol 232-233
n-Butyl Alcohol 232-233
sec-Butyl Alcohol 264
Butylbenzene 230

CARBON BISULFIDE 225
CARBON BLACK (LYNN PROCESS) 226
CARBON BLACK (OIL BLACK) 227
Carbon Tetrachloride 228-229
Carbon Tetrachloride 271
CHLORINATED METHANES 228-229
Chloroform 228-229
CUMENE 230
1-Cyanobutadiene 209

Dichloroethylene 283
Diethanolamine 231
Di-Ethylene Glycol 242
Di-Isopropylbenzene 230
Dimethylamine 263
DIRECT OXIDATION OF PROPANE-BUTANE 232-233
Dodecylbenzene 210

Epichlorohydrin 252-253
ETHANOLAMINES 231
ETHANOL 234
ETHYL ALCOHOL AND ETHYL ETHER 235
ETHYLBENZENE 236
Ethylbenzene 230
ETHYL CHLORIDE 237
ETHYL CHLORIDE 238
Ethyl Ether 235
ETHYLENE DICHLORIDE 239
Ethylene Dichloride 289
Ethylene Dichloride 290
Ethylene Glycol 242
ETHYLENE OXIDE 240
ETHYLENE OXIDE 241
ETHYLENE OXIDE AND ETHYLENE GLYCOL 242
ETHYLENE PRODUCTION 243
ETHYLENE WITH PEBBLE HEATER 244
ETHYLENE AND PROPYLENE 245

ETHYLENE PRODUCTION 246
m-Ethyltoluene 291
o-Ethyltoluene 291
p-Ethyltoluene 291

FISCHER TROPSCH 247
FORMALDEHYDE (Uhde) 248
FORMALDEHYDE AND ACETALDEHYDE 249
Formaldehyde 232-233

GLYCEROL (Acrolein and Hydrogen Peroxide) 250
GLYCEROL (Formic Acid) 251
GLYCEROL (Epichlorohydrin) 252-253
Glycols 232-233

HYDRAZINE 254
HYDROGEN CYANIDE 255
HYDROGEN PEROXIDE 256

iso-Butylene 275
ISOPROPYL ALCOHOL 257
Isopropyl Ether 257

Lactronitrile 209

MALEIC ANHYDRIDE 258
METHANOL 259
METHANOL 260
METHANOL 261
METHANOL 262
Methanol 232-233
METHYLAMINES 263
Methyl Chloride 228-229
METHYL ETHYL KETONE AND ACETONE 264
Methyl Ethyl Pyridine 266
METHYL MERCAPTAN 265
Methylene Chloride 228-229
METHYL VINYL PYRIDINE 266
Monoethanolamine 231
Monomethylamine 263
Mono-Ethylene Glycol 242
Mono Vinyl Acetylene 209

Nitric Acid 217
NITROPARAFFINS 267

OXO PROCESS 268

Paraformaldehyde 232-233
Paraldehyde 266
PENTAERYTHRITOL 269
Pentamer 279
PERACETIC ACID 270
PERCHLOROETHYLENE 271
Perchloroethylene 283
PHENOL FROM CUMENE 272-273
PHTHALIC ANHYDRIDE 274
POLYBUTENE 275
POLYETHYLENE (HIGH PRESSURE—ICI) 276
POLYETHYLENE (LOW PRESSURE—SLURRY-PROCESS) 277
POLYETHYLENE AND POLYPROPYLENE (LOW PRESSURE—ZIEGLER) 278
Polypropylene 278
n-Propyl Alcohol 232-233
Propylene 245
PROPYLENE TETRAMER 279
Propylene Trimer 279

STYRENE 280
SULFUR RECOVERY 281
SYNTHOL PROCESS 282

Tetrachloroethane 283
TRICHLOROETHYLENE 283
Triethanolamine 231
Tri-Ethylene Glycol 242
Trimethylamine 263

UREA 284
UREA 285
UREA 286
UREA (Inventa) 287

VINYL ACETATE 288
VINYL CHLORIDE FROM ACETYLENE 289
VINYL CHLORIDE FROM ETHYLENE 290
VINYL TOLUENE 291

SEPARATION SECTION

AROSORB 292
AZEOTROPIC FRACTIONATION 293
BUTADIENE EXTRACTION 294
BUTADIENE EXTRACTION 295
EXTRACTIVE CRYSTALLIZATION with UREA 296
EXTRACTIVE DISTILLATION (Acetonitrile) 297
EXTRACTIVE DISTILLATION OF ALCOHOLS 298
EXTRACTIVE DISTILLATION (AROMATICS RECOVERY) 299
FRACTIONATION AND FRACTIONAL CRYSTALLIZATION OF XYLENES 300
HYPERSORPTION 301
ISOBUTYLENE EXTRACTION 302
MODIFIED SO_2 EXTRACTION 303
UDEX EXTRACTION 304

CONTRIBUTORS

AMOCO CHEMICALS CORPORATION
Fischer Tropsch 247

THE ATLANTIC REFINING COMPANY-VULCAN-CINCINNATI, INC.
Ethylene Oxide 240

BECCO CHEMICAL DIVISION OF FOOD MACHINERY & CHEMICAL CORP.
Hydrogen Peroxide 256

CELANESE CORPORATION OF AMERICA
Direct Oxidation of Propane-Butane 232-233

CALIFORNIA RESEARCH CORPORATION
Phthalic Anhydride 274

CHEMICAL CONSTRUCTION CORPORATION
Acetylene (BASF) 207
Ammonia 211
Urea 284

COMMERCIAL SOLVENTS CORPORATION
Ammonium Nitrate 218
Methanol 259

CONTINENTAL OIL COMPANY
Alkyl Aryl Sulfonates 210

COSDEN PETROLEUM CORPORATION
Polybutene 275

ESSO RESEARCH & ENGINEERING COMPANY
Butadiene from Butenes 224
Butadiene Extraction 294
Isobutylene Extraction 302

FOSTER WHEELER CORPORATION
Ammonia 214
Methanol 261
Urea 285

THE FLUOR CORPORATION, LTD.
Ammonia 213

THE GIRDLER COMPANY
Ammonium Nitrate 217
Hydrogen Cyanide 255
Sulfur Recovery 281

HOUDRY PROCESS COMPANY
Butadiene from Butane 223

THE M. W. KELLOGG COMPANY
Ammonia 215
Ethylene Production 246
Synthol Process 282

THE LUMMUS COMPANY
Ethylene and Propylene 245
Acetylene (Wulff) 208

LYNN CARBON BLACK CO., INC.
Carbon Black 226

ARTHUR G. McKEE & COMPANY
Ammonia (Uhde) 216
Formaldehyde (Uhde) 248
Methanol (Uhde) 262

MONTECATINI
Acetaldehyde 206
Urea 286

NAUGATUCK CHEMICAL
Vinyl Acetate 288

NITTO CHEMICAL INDUSTRY CO., LTD.
Methylamines 263

PHILLIPS PETROLEUM COMPANY
Ethylene with Pebble Heater 244
Butadiene Extraction 295

SHELL DEVELOPMENT COMPANY
Ethanol 234
Ethyl Chloride 237
Extractive Distillation (Aromatics Recovery) 299
Extractive Distillation (Acetonitrile) 297

PENNSALT CHEMICALS CORPORATION
Amyl Alcohol 220

SCIENTIFIC DESIGN COMPANY, INC.
Ethylene Oxide 241
Maleic Anhydride 258
Perchloroethylene 271

STONE & WEBSTER ENGINEERING CORPORATION
Ethylene Oxide and Ethylene Glycol 242
Ethylene Production 243
Extractive Distillation of Alcohols 298
Isopropyl Alcohol 257
Modified SO_2 Extraction 303

SUN OIL COMPANY
Arosorb 292

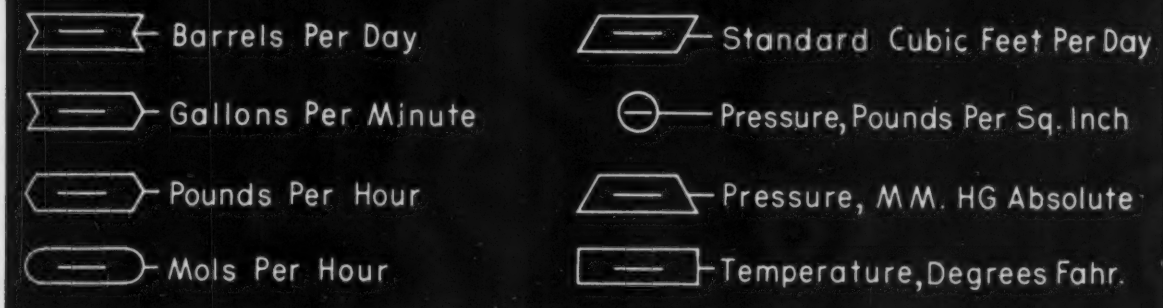
UNION CARBIDE CHEMICALS COMPANY
Peracetic Acid 270

UNION OIL COMPANY
Azeotropic Fractionation 293
Hypersorption 301

UNIVERSAL OIL PRODUCTS COMPANY
Cumene 230
Propylene Tetramer 279
Udex Extraction 304

VULCAN-CINCINNATI, INC.
Urea 287

Flow Diagram Symbols Used In This Issue...



Petrochemicals—the Boom Continues!

New developments and products from older petrochemicals along with new petrochemicals will keep the industry doubling every five years.

Robert L. Bateman, Union Carbide Chemicals Company, New York City

BY THE END of 1957, the annual rate of production of petrochemicals will have crossed the 40 billion-pound level. For the full year of 1957, total tonnage is estimated at 38.7 billion pounds, an increase of 3.2 percent over the 37.5 billion pounds for 1956. This year's output, however, is 18 percent greater than the tonnage for the "boom" year 1955.

The dollar value of 1957 petrochemical production will again be at a new high of $4.75 billion, 4.4 percent increase over 1956. The value of all chemicals produced will be $8.75 billion. This latter estimate includes the chemicals from other raw materials such as coal, minerals and agricultural products as well as those of petrochemical origin. The chemicals derived from petrochemical sources represent 54.5 percent of the value but, on a tonnage basis, account for only 25 per cent of total chemical output.

The aliphatics continue to dominate the three classifications of petrochemicals, with production of 24.4 billion pounds in 1957. Inorganics, with an output of 10.7 billion pounds, are about one billion pounds above the 1956 level, reflecting the continued emphasis on the sale of ammonia for direct application in agriculture. While petrochemical aliphatics dominate the aliphatic segment of the chemical industry—about 86 percent of all aliphatic chemical production is petrochemically derived, this is not so with the aromatics. Large quantities of aromatics are still based on coal and by-products of the coking of coal. As a consequence, only 4 billion pounds, or one-half of the total of aromatic chemical production is of petrochemical origin.

The Continuing Pressure of higher raw materials cost, increased construction cost of new equipment, higher labor rates, and advancing transportation charges have affected the average sales price of the large aliphatic group of petrochemicals which comprises approximately three-fifths of all petrochemical production. The aliphatic petrochemicals include such heavy tonnage items as ethylene glycol, ethyl alcohol, vinyl chloride, methanol, isopropanol and butanol. The average market price for the aliphatic petrochemicals has risen 5 percent in the past two years to an overall average sales value of 15 cents per pound compared with 14.2 cents in 1955.

The same inflationary pressures have been pushing upward the cost of the aromatic petrochemical intermediates and the inorganic petrochemicals but, due to competitive reasons, the averages have remained practically unchanged during this two year period. The average sales value of the aromatic intermediate petrochemical is 18 cents per pound. The recent sizeable decrease in the market price of styrene is sufficient to offset small increases in the market price of aniline, phenol and phthalic anhydride. These four items comprise a large proportion of the aromatic petrochemicals. The inorganic petrochemicals on the average are unchanged due to the extremely competitive ammonia situation.

Petrochemicals are considered to be synthetic chemicals derived from petroleum or natural gas hydrocarbons which, in many cases, are processed further by allied industries such as rubber, paint, textile, agricultural, detergent and drug. Only that portion of the chemical operations which converts these natural raw materials to chemicals for the allied industries is included in the production and value estimates for the petrochemical industry.

In 1957 the petrochemical industry has not escaped the effect of the "rolling adjustments" in several major consumer goods industries which has

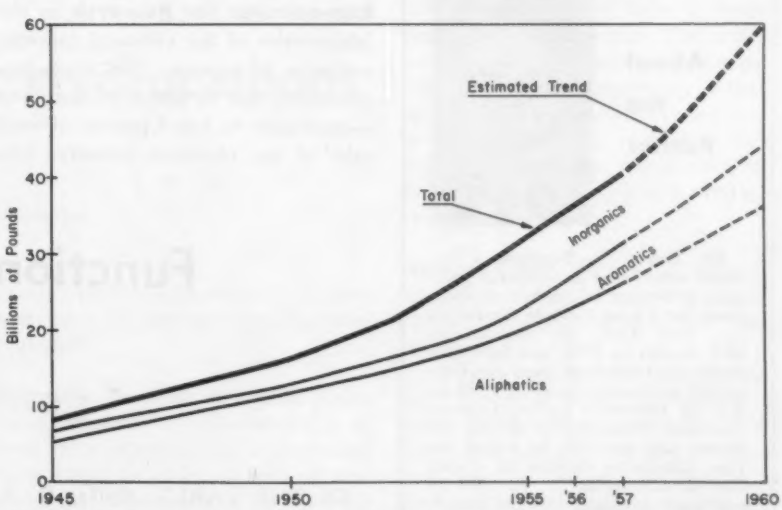


FIGURE 1—U. S. petrochemicals production projected up to 1960. Notice that aliphatics continue to dominate with inorganics showing a slight increase.

Petrochemicals—The Boom Continues . . .

U. S. Petrochemicals Production

	POUNDS—(In Billions)				
	1955	1956	Percent Change 1955-1956	Estimate 1957	Percent Change 1956-1957
PETROCHEMICALS					
Aliphatics	20.15	23.7	17.6	24.4	2.9
Aromatics	3.2	3.8	18.7	4.0	5.3
Inorganics	9.45	10.0	5.8	10.3	3.0
All Petrochemicals	32.8	37.5	14.3	38.7	3.2
All Chemicals	134.8	144.3	7.0	153.0	6.0

	DOLLARS—(In Billions)				
	1955	1956	Percent Change 1955-1956	Estimate 1957	Percent Change 1956-1957
PETROCHEMICALS					
Aliphatics	$ 3.00	$ 3.5	16.7	$ 3.60	2.9
Aromatics	0.58	0.65	12.1	0.72	10.8
Inorganics	0.37	0.40	8.1	0.43	7.5
All Petrochemicals	$ 3.95	$ 4.55	15.2	$ 4.75	4.4
All Chemicals	$ 7.50	$ 8.25	10.0	$ 8.75	6.1

included the automobile, housing, major appliances, textile, etc. Nevertheless, the basic long-term growth trend is still upward although not as great as was apparent in 1955 and 1956. There has been no slackening in the flood of new synthetic materials nor a downtrend in the expenditures for expansion of plant facilities. By 1960 petrochemical production should reach the 60 billion pound annual rate. In the interim, and to attain production capacity, expansion of plant facilities must run in the vicinity of $750 million to $1 billion per year.

To follow the same growth curve of the past decade, established uses for the older petrochemicals will continue to expand at a rate consistent with the over-all expansion of the general economy. New developments and new products based on these older petrochemicals, and new chemical structures of petrochemical origin will maintain the growth rate at a level above that for either the over-all chemical industry and of industry in general.

Expenditures for Research in the laboratories of the chemical industry continue to expand. This year's expenditures will be above $300 million —equivalent to 3 to 4 percent of total sales of the chemical industry. The industry is expanding its efforts in the continuous search for new products and this will require still greater research budget appropriations. Heavy emphasis is being placed on polymers directed towards applications that will expand the uses of products normally considered in the rubber, textile, or plastics industries. New and improved rubbers will require increased production of butadiene and styrene but, in addition, a number of new petrochemical monomers must come from the research laboratory to overcome known deficiencies of the present-day elastomers.

The number of synthetic fibers flowing from the laboratories into commercial production is already most impressive. These not only supplement the supply of natural fibers but also create new fabrics and styles which are not possible with the natural fibers alone. Heavy development expenses in the initial stages are required but, as the fibers become available and consumer value is established in the next few years, heavy plant expansions will be required to supply the basic petrochemicals for their synthesis.

The greater speeds and higher power demands of the automobile and aircraft engines call for new fuels, lubricants, and fluids. These new materials will be products of organic synthesis from the laboratory and many will be based upon petrochemical raw materials.

Major research and development break-throughs in any of these areas can lead to a repetition of explosive growth such as has been experienced in the past five or ten years with polyethylene, synthetic detergents, and ammonia, with heavy capital expenditures for new facilities and the enlargement and modernization of present petrochemical production units.

About the Author

Dr. Robert L. Bateman, a frequent contributor to technical journals, is director of product development for Union Carbide Chemicals Co., New York. He received his M.S. degree in 1933, and his Ph.D. degree in 1935, both from the University of Pennsylvania. In 1935 he was an Industrial Fellow, Organic Synthesis Fellowship at Mellon Institute, and in 1937, he joined the Fine Chemicals division of Union Carbide Chemicals Co. In 1944 he was made manager of that department, then in 1954 he was promoted to his present position.

Functional Fluids

Robert I. Stirton
Oronite Chemical Company
San Francisco

IN THE EARLY 1940's, U. S. Military Specification MIL-O-5606 was issued to cover the requirements of a petroleum based hydraulic fluid and lubricating oil. The temperature maximum was set at 160 F. About

25 million gallons of this specification fluid have been used in the last 15 years.

The need for hydraulic fluids which would meet the more rigorous demands brought about through aircraft and missile developments became evident in the late 1940's. Oronite Chemical Company and its research affiliate, California Research Corporation, together with others in the chemical processing industry, undertook active research and development programs to meet these needs.

In June, 1955 U. S. Air Force Specification MIL-H-8446 was issued. This sets forth the service requirements for a non-petroleum base aircraft hydraulic fluid to operate in the temperature range —65 F to 400 F. To date, no hydraulic fluids complying in all respects with this specification have been offered by the various manufacturers but several fluids capable of operation of hydraulic systems over this approximate temperature range are currently being supplied. Most active in this field have been Oronite Chemical Company, which offers commercially two fluids based on siloxane compounds; Monsanto Chemical Co. with two fluids based on ortho silicate esters; General Electric Co. with one fluid based on a chloro-silicone base; Bray Chemical Co. with one fluid of silicate-ester type base; Union Carbide Corporation and R. M. Hollingshead Corp. which have been offering water based type fluids as Military Specification products. Approximately 30,000 gallons of hydraulic fluids in this general category were apparently sold during 1957 and the demand curve is rising sharply.

Another class of functional fluids, based on phosphate esters, also have achieved some commercial significance in recent years. Designed to minimize fire hazards, such fluids are used by some commercial air lines. The operable temperature range is approximately that served by the petroleum oils (Spec. 5606 fluids) and these ester compositions also suffer from a high specific gravity limitation. There appears to be no clear-cut indication as to whether they will continue to be a significant factor in this field.

The need for hydraulic fluids which are capable of meeting requirements more rigorous than those now existing is certain as aircraft design and missiles undergo further developments. We may well expect the issuance of a Specification which will call for hydraulic fluids to function up to 600 F and 700 F.

About the Author

Robert I. Stirton is manager of the Product Development department, Oronite Chemical Co., San Francisco. Stirton received his B.S. degree in 1930, and his Ph.D. degree in 1943 in chemical engineering, both from California Institute of Technology, Pasadena. From 1934 to 1947, Stirton worked for Union Oil Co., of California in various positions in research and export sales. In 1947 he joined Oronite.

Aromatic Hydrocarbons

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FIVE-BILLION GALLONS a year would be a conservative estimate for the capability of existing reforming units to produce benzene, toluene and xylene from crude oil cuts. Most of this, of course, is produced as a mixed aromatic stream to boost gasoline octane rating. U. S. tariff reports show that 370-million gallons of BTX aromatics from petroleum sources were available for sale in 1956. Thus, only about 7 percent of reforming capacity was used to produce chemical raw materials.

Benzene, the most important of the three aromatics as a chemical, is of least value in raising the octane rating of gasoline. In addition, benzene precursors, cyclohexane and methylcyclopentane, have higher octane blending values and so there is little incentive for a refiner to produce benzene except for sale to the chemical industry. Most of the benzene goes into rubber, plastics and protective coatings—all growth industries. Sixty percent is consumed in the production of styrene and phenol, the remainder is used for detergent alkylate, aniline, maleic anhydride, nylon, chlorobenzene, nitrobenzene, insecticides and other minor uses.

Total domestic demand for benzene increased from 242-million gallons in 1951 to 345-million gallons in 1956. Current demand is about 355-million gallons annually and should increase at a rate of 25 to 30-million gallons a year for the next several years.

Toluene and Xylene. Production of 255-million gallons from petroleum reported in 1956 by the U. S. Tariff Commission is misleading to the extent that a sizable percentage actually ended up in high octane gasoline. The remainder was used principally as solvents with only a minor part going into chemicals manufacture. To chemical consumers, however, the petroleum industry represents a dependable source of quality toluene and xylene which is not affected by the vagaries of coking operations.

Toluene is in long supply and this situation is likely to continue. This presents no particular problem to the petroleum refiner because he can utilize any excess in gasoline. While he can do the same with xylene, this chemical appears to have a bright future as an intermediate. The ortho-, meta- and para-isomers can be oxidized to the corresponding dibasic acids (phthalic, iso-phthalic and terephthalic) which, in turn, find their way into alkyd resins, polyesters, films, fibers, plasticizers, dyes and pharmaceuticals.

Foreign Trade. Except for benzene imports and toluene exports, foreign trade of BTX aromatics has been negligible.

Benzene imports have been increasing for several years and reached a peak of 66-million gallons in 1956. The trend has reversed and the next few years should see a pattern of steadily decreasing demand for foreign benzene.

Toluene exports declined from a

high of 21-million gallons in 1954 to less than 9-million gallons in 1956. This year may well see a return of the 1954 pattern because 9-million gallons were shipped during the first half.

Expansion. Gulf Oil has announced a new 30-million gallon per year benzene unit to be completed in 1958. This, along with new aromatics capacity at Humble, Delhi-Taylor, Richfield, Ashland and Vickers plants is a good indication that these refiners are bullish concerning the long range ability of phenol, aniline and styrene, the major uses, to take up the current benzene oversupply. The decision of other refiners to add BTX extraction facilities, however, will depend on the demand of the chemical industry balanced against their octane requirements.

Summary. It appears that the chemical industry's use of BTX aromatics will continue to grow at a modest rate during the next few years with xylene probably offering the greatest growth potential. So long as the octane race continues, however, chemicals will consume only a very small percent of the total aromatics produced by catalytic reforming.

About the Author

John J. O'Connell III, is vice president-marketing for Amoco Chemicals Corporation, Chicago. O'Connell received his A.B. degree in chemistry in 1937, and his M.S. degree in organic chemistry in 1938. In 1955 he received a M.B.A. degree in marketing from New York University. Prior to joining Amoco, O'Connell was with Shell Chemical Corporation, and was a part-time lecturer at Columbia University. In his present position, he is responsible for the administration and organization of the marketing department.

Pesticides

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Pesticide Advisory Service
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A NEWER outlet for petrochemicals in the last decade is in the field of agricultural pesticides—insecticides, fungicides and herbicides. Prior to World War II the pesticides used were mainly inorganic in nature and comprised essentially arsenicals, copper sulfate and chlorates. Pyrethrum and rotenone, the reliable botanicals, rounded out the major materials used.

The modern pesticide industry as we know it today had its start with the advent of DDT in the latter part of World War II. Swiftly following in 1944 and 1945, there were the other chlorinated hydrocarbons such as chlordane, lindane, benzene hexachloride, toxaphene and many other similar materials. Within the past few years, there have been the introduction of a whole series of phosphate materials lead by parathion, malathion and similar type substances. In addition, endrin, dieldrin and heptachlor moved in. The current rage in the insecticide line are the so-called sytemics which are a first chemical cousin to the phosphates.

Table 1 shows that there was a trend toward the organic materials in the period immediately following the introduction of DDT and various chlorinated hydrocarbons. However, in the last two years there has been increasing importance laid to the use of the old inorganic materials. This has been accomplished for the most part by the fact that insect resistances have been raised to these chlorinated products, and also to the Miller Bill which lays stringent conditions on the amount of residues which are permitted. The topic will be discussed later.

The total volume of agricultural insecticides, that is the technical materials used in their manufacture, amounted to more than 300 million pounds. The total dollar volume at the technical level approximates $173 million while at the farmer or consumer level, it has been estimated at well over $1 billion.

The pesticide industry is marked by growing pains as a newcomer to the chemical industry as such. Many of the larger producers of the technical chemicals seek to upgrade the value of their essential raw materials such as chlorine, alcohol, and acid by going into the manufacture of the technical materials. Then some of the more integrated producers have sought to upgrade the value of even the technical materials. These have gone into the manufacture of semi-concentrate and finished insecticides ready for sale to the dealer and the consumer.

Predicting requirements in the pesticide industry is difficult since weather, federal agricultural farm policy, and the problems related to the bust or boom of domestic agriculture affects sales, consumption, stock positions, as well as capital expenditures which will be made by management. It has not been possible in the pesticide field to educate the farmers into the use of insecticides as a preventive measure, but for the most part, these materials are used only for control when the insect attacks. Attempts have been made in the past few years to educate cotton farmers by requiring pest control where financial assistance from banks are involved. However, only moder-

TABLE 1—Pesticide Consumption

Domestic Use (Thousands of Pounds)
(Representing disappearance at the producer level, crop year ending September 30)

PRODUCT	1950	1951	1952	1953	1954	1955	1956	1957 (Est.)
BHC and Lindane	8,548	9,600	11,067	7,085	8,500	7,800	9,450	7,900
2,4-D	17,600	23,494	25,298	26,122	27,251	28,000	32,000	31,000
DDT	57,638	72,688	70,074	52,748	45,117	61,800	75,000	70,000
2,4,5-T	1,261	2,822	2,937	4,625	2,906	2,500	4,400	3,500
Polychlorinated Chemicals[1]	N.A.	N.A.	N.A.	34,500	35,500	57,000	61,570	63,000
Copper Sulfate	64,000	60,000	70,000	55,000	60,000	58,000	50,000	40,000
Calcium Arsenate	38,000	39,500	4,800	7,212	3,100	4,232	21,000	22,000
Lead Arsenate	27,900	30,100	17,500	14,196	15,620	14,776	11,558	12,000
Pyrethrum	9,373	7,098	6,729	8,110	7,610	7,712	6,960	7,000
Rotenone	9,846	7,027	3,520	4,468	6,428	5,954	6,350	5,950

[1] Basket for Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Toxaphene.
Source: U. S. Department of Agriculture—National Agricultural Chemicals Assn.

ate progress has been made along this line.

Federal legislation in the form of the Miller Bill has created further problems for the introduction of new pesticidal materials. Essentially this law requires certain toxicological information to be available prior to the time when federal regulatory authorities will permit use of newer materials on certain crops. Considerable expense has been the result of the strict enforcement of the Miller amendment and the full effect is being felt for the first time this year. It had been hoped that the agricultural industry could take the Miller amendment in its stride, but in actual practice it has proven to be a major headache particularly for newer products.

Table 1 shows the pesticide consumption for domestic use only for the period 1950 to 1957. These figures represent disappearance at the producer level only, and therefore, can assume to be the actual use of these various materials for agricultural pesticide use.

Competition in the agricultural pesticide field has brought into play the use of consignment stocks where integrated producers will actually consign finished materials in the hands of dealer, and if need be, the ultimate user, the farmer. This has been brought about largely by the fact that insecticides are used over a very short period of time making it virtually impossible to move such large stocks in such a short time. In order to accomplish and solve the matter of logistics, companies have resorted to consignment stocks. Competitive conditions, of course, have offered further inducements at certain levels so that this practice has represented a nightmare to management. Declining consumption and declining prices have aggravated this problem so that the management levels of these companies are trying desperately to cut out consignment stocks for the coming season.

With the constant demand for more efficient production of the limited acreage available, the volume of agricultural pesticides should improve. Education on the part of the agricultural pesticide industry has been undertaken in a world-wide program sponsored by the National Agricultural Chemical Association.

Desire for malaria-free countries and bringing the effective agricultural pesticides manufactured here in the U. S. to these other countries, has expanded the amounts of material that are exported by U. S. producers. These programs are aided and abetted by International Cooperation Administration as well as the various health and agricultural organizations sponsored by the United Nations throughout the world.

A major market is developing in the U. S. for large control programs sponsored by Federal and State governments and applied by aerial application. These include but are not restricted to the grasshopper control programs as well as the gypsy moth control program sponsored by the U. S. Dept. of Agriculture. This latter program has been an attempt to wipe out this dread insect and confine it for the most part to the Middle and North Atlantic states. Control of spruce budworm in the Pacific Northwest as well as in the outer Canadian provinces has also consumed great quantities of technical DDT for these control programs.

About the Author

Melvin Goldberg received his A.B. degree from Johns Hopkins University in 1935, and his M.S. degree from Georgetown University in 1940. Following graduation from Georgetown, he joined the Insecticide & Fungicide Unit of the War Production Board where he remained until 1945. In 1948 he founded and now owns Pesticide Advisory Service. From 1950 to 1952 he served as a consultant to the U.S. Department of Agriculture.

Olefins

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VIRTUALLY the entire aliphatic segment of the petrochemical industry is based upon olefins produced by thermal or catalytic cracking of petroleum distillates. As a result these raw materials have the same bright future described by Dr. Bateman for aliphatics.

Ethylene. Of all the olefins, ethylene is presently consumed in the largest volume and enjoys the brightest future. About 70 percent of the ethylene consumed by the petrochemical industry is used to produce ethyl alcohol, ethylene oxide and polyethylene. The demand for synthetic ethyl alcohol is determined to a large extent by the availability of fermentation alcohol from molasses and as a result has resulted in a fairly constant volume outlet. Recent changes in the molasses supply may have a profound effect on this picture causing considerable increase in demand for synthetic alcohol.

Ethylene oxide capacity is currently well ahead of demand. If expansion of the ethylene market through this outlet is to continue, it will undoubtedly occur through products other than ethylene glycol. One of the brightest new outlets appears to be in polyethers for liquid detergents.

The use of high and low pressure polyethylene continues to grow rapidly making this field one of the most fertile for expansion of the ethylene market. It is expected that polyethylene will become the first billion pound plastic material around 1960.

Propylene. At present the principal uses for propylene are in the production of isopropyl alcohol, tri-and tetrapropylene and cumene. With the exception of the tri-and tetrapropylene, these markets represent a fairly constant volume. With the recent developments in polymerization techniques, the most promising outlet for propylene is for the production of high molecular weight polymers. Because of its ready availability and low price, this use could stimulate propylene to a more rapid growth than ethylene has enjoyed.

Butylenes. The demand for the butenes which find their principal outlets in butyl alcohol, butadiene and

polybutene production will probably increase at a much lower rate than the lower olefins. One bright spot in the picture is isobutylene. With the acceptance of butyl rubber for the production of tires, the use of isobutylene will increase markedly over the next few years.

Butadiene. At the present time, butadiene production capacity is considerably greater than consumption. However, the increasing rate of consumption of synthetic rubber throughout the world coupled with the predicted shortage of natural rubber and new uses such as production of resins and dibasic acids should soon close this gap.

Isoprene. Isoprene has held a relatively small share of the olefin market. With the announcement of several of the rubber companies that they have perfected "synthetic natural" rubber and with the need for a material to extend the natural rubber supply, this use may increase rapidly over the next few years.

Tri and Tetrapropylene. Tetrapropylene which is used extensively in the production of dodecyl benzene for synthetic detergents, has paralleled the phenomenal growth of synthetic detergents. With the advent of the liquid detergents based on nonyl phenol, tripropylene has also found a rapidly expanding market. These materials will continue to grow with the detergent market.

About the Author

C. H. Thomas is a technical service coordinator for Enjay Company, Inc., New York, where he coordinates the activities of Enjay laboratories with field requirements, and provides technical back-up for chemicals and intermediates sold by Enjay. Thomas received his B.S. degree in naval Science in 1946, his B.S. degree in chemistry in 1950, and his Ph.D. degree in organic chemistry in 1953. Prior to joining Enjay, he was a research chemist for Esso Research and Engineering Co.

Plastics

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POLYETHYLENE gets the biggest headlines. The branched or low density type polyethylene is currently being produced by twelve plants in the U. S. with a combined annual capacity of 815 million pounds. By the middle of next year, it is estimated that this annual capacity will have been increased to 965 million pounds. The linear or high density type polyethylene is currently being produced in three production plants having a combined annual capacity of approximately 145 million pounds. By the end of this year, it is expected that this capacity will have grown to seven plants capable of turning out 260 million pounds per year, and by Mid-1958 the plants will have grown to eight, and the capacity to 325 million pounds per year.

Vinyls. While polyethylene has been in the headlines, the vinyls have shown that they too are a plastic material with a big and growing future still ahead, even though marketed twice as long. The March estimate of the Tariff Commission showed a production of 557 million pounds of polyethylene in 1956, whereas the vinyls are estimated at 752 million—a substantial growth compared with the 703 million produced in 1955. As processors and fabricators learn to embellish vinyl film and sheeting with ever-new and interesting decorative effects, the markets will broaden. The vinyl surface floor is superior in many ways; hence it will ultimately outmode most of the other hard-type flooring. Luminous ceilings from rigid vinyl sheets are in their infancy, yet most adaptable to modern design. There is now available a cast vinyl film, both rigid and plasticized, with a clarity approaching that of window glass. Such a desirable variety of properties exists in this class of plastic that designers and manufacturers of the future must inevitably find a growing number of applications for the products, but in all probability the increased business to be expected from such sources will be outdistanced by the growth in the use of vinyl resins as protective coatings. This trend is already evident in current use.

Styrene. The latest statistics on styrene production would seem to confirm that styrene latices are being outmoded by the vinyls, but the rubber modified styrenes, which give greater impact strength to moldings and extrusions, are greatly enhancing the usefulness of the material. This fact, coupled with the development of vacuum or drape molding, and the increasing use of styrene foams, gives the styrenes a continuing upward trend.

Phenolics, which were the original synthetic resin, have been suffering in competition with the newer materials in recent years, but this by no means indicates that they will ultimately be outmoded. The present production of over 500 million pounds is a good indication of their continuing varied usefulness. The recent introduction of trimethylolphenol, which in effect is a monomeric form of phenolic resin, makes possible the combination of phenolic properties with other materials, hence will no doubt broaden phenolic use.

Melamines and Ureas. In 1955, 328 million pounds were produced, a 50 percent advance over 1950. Their continued use in protective coatings, decorative laminates, and table ware indicates that this rate of growth will continue.

Fluorocarbons and nylons are relatively small volume performers compared to all the other petrochemicals plastics. Recent substantial expansion in productive capacity bear out their importance as basic materials for industry. The fluorocarbons bring to engineers and designers a combination of high heat resistance coupled with amazing resistance to corrosive chemicals, while the nylons are outstanding in their combination of

toughness and wearability, coupled with heat resistance and dimensional stability.

Polyesters and Epoxies. Materials for moulding fiberglass have an exciting future. So far, polyesters have been the predominant resin, but the epoxies are marking rapid strides in this field. The epoxies can likewise look forward to increasing use in coatings and in cast structures such as currently employed for tools and fixtures.

Cellulosics. While not ordinarily regarded as being based on petrochemicals, most everything used in their manufacture to modify the cellulose is so derived. Thus the industry can look forward to increasing consumption of acetic anhydride, butyric acid, and propionic acid. These tough, colorful materials are finding increasing use in extruded pipe, signs, and shoe heels.

Acrylics. Recent improvements have resulted in greater toughness and ease of molding for injection molding materials, and improved resistance to outdoor exposure in the case of resins employed in paints and as modifiers for polyester resins. Such improvements guarantee a growing usefulness, accompanied by increasing volume, in this class of resins.

About the Author

Gordon Brown is vice president of Market Research for Bakelite Company, Division of Union Carbide Corporation. Brown has been actively engaged in the field of plastics sales since 1919.

Fluorochemicals

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LAST YEAR, hydrofluoric acid, the production barometer for the fluorochemical industry, reached a total output estimated at 139,000 tons. This figure reflects the current expansion of domestic production facilities to fill demands for HF and holds significance for the petrochemical field.

There are two important aspects to the fluoro-chemical picture: the passive role of hydrofluoric acid in meeting the needs of various dependent industries, and the active role of HF in stimulating industry to provide more materials for new fluoro-chemicals.

Increased use of HF in the fluorochemical field is tied directly to the growth of fluorinated hydrocarbons in recent years. Fluorocarbon gases are used primarily as refrigerants for industrial, household and commercial refrigeration and air conditioning equipment, and as propellants for aerosols. Increased public acceptance of push-button sprayers and of air conditioners, home freezers, etc. has boosted the market for these products materially, and fluorochemical producers have geared themselves accordingly. The three chemical companies now making fluorinated hydrocarbon refrigerants and propellants are General Chemical Division, Allied Chemical & Dye Corporation; E. I. duPont de Nemours, and Pennsalt Chemicals Corporation. They are soon to be joined by a fourth, Union Carbide & Carbon Corporation.

Studies by independent market analysts indicate that these producers have sufficient installed and projected capacity to meet the entire anticipated demand for the foreseeable future. As their output increases, their raw material requirements will swell accordingly, creating demands on petrochemical producers. For example, the 1962 production of carbon tetrachloride (a major hydrocarbon source for these gases) will probably top the 200,000 ton mark.

The extent to which the fluorochemical field may expand in other directions depends on the progress of several new products. Plastics made of fluorinated hydrocarbons are already on the scene and are becoming increasingly available. For example, they are being used by the petroleum industry as highly effective gaskets because they retain their flexibility over a wide temperature range, are relatively impermeable to gases, have zero moisture absorption and are inert, nonflammable and non-corrosive. Other new fluorochemical products, now in the experimental stage, include synthetic lubricants and adhesives. There is also a potential for quiet growth in fluorine chemicals which are not connected with the petroleum industry.

At present there is little doubt regarding the future trend of fluorochemicals. The picture is one of steady growth with corresponding increases in demands for petroleum derivatives required in their manufacture.

About the Authors

James P. Farrell is director of sales for the General Chemical Division, Allied Chemical & Dye Corporation where he directs the sales program covering acids and other basic industrial chemicals, laboratory reagents and fine chemicals, agricultural chemicals, and special products. Farrell has been with the company for 22 years. He is a graduate of La Salle College where he received a B.S. degree in business administration.

Synthetic Rubber

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THE UNITED STATES in 1957 will import and produce approximately 1,700,000 long tons of natural and synthetic rubbers. This is a high figure and it will seem unusually high when it is recalled that in 1939, just before World War II, this country imported only 497,383 long tons of

natural rubber and produced only 1750 long tons of synthetic rubbers, neoprene (CR) and polysulfide types. The amount of natural rubber imported in 1957 will be only slightly more than that in 1939, about 550,000 long tons.

SBR, (styrene-butadiene type of synthetic rubber) will be increased about 5 percent over that in 1956, to 910,000 long tons. A new plant for producing neoprene is in action and therefore greater production will be 105,000 long tons. The nitrile rubbers (NBR type) will slowly increase to 38,000 long tons. The polysulfide rubbers are rolling along, the silicone rubbers are continuing to increase rapidly, and the polyacrylates, chlorosulfonated polyethylenes, carboxylic rubber, the fluororubbers and the vinylpyridine types, will all increase although their productions are rather small.

Butyl rubber (IIR type), is on the upgrade, with production at 80,000 long tons. Lower production occurred when tubeless tires were adopted for new automobiles but now tire casings of IIR are on a control test market and no doubt will achieve success.

The polyurethane rubbers are worth watching. They readily and quickly form foams which are being used in more and more applications. The number of diisocyanates has increased and the prices are lower. Therefore the costs are dropping continuously. Only treads for tires have been produced but research and development should give complete tires and these will be wonderful because of the high resistance to abrasion, their great tear strength, and low hysteresis value.

The synthetic natural rubber (NR type) hydrocarbon is being produced in two pilot plants. Isoprene is the starting product in each case. Isoprene is not as cheap as butadiene but it is likely that good research on the preparation of isoprene should make it cheaper than at present or at least not allow the price to go up. Synthetic natural rubber hydrocarbon is a great guarantee against any cut off of natural rubber from the Far East.

Non-tire rubber products are increasing in proportion and will increase the consumption of rubber. The use of latices of natural and synthetic rubbers is increasing, with synthetic latices gaining the lead. The new federal road building program will expand the consumption of rubber for trucking and for passenger car travel.

About the Author

Harry L. Fisher, past president of the American Chemical Society (1954), received his A.B. degree from Williams College in 1909, his A.M. degree from Columbia University in 1910, his Ph.D. degree from Williams College in 1912, and an honorary D.Sc. degree in 1953. He commenced his long and successful career in the rubber industry as a research chemist with B. F. Goodrich Company in 1919, then in 1926 he moved to United States Rubber Company as a research chemist. In 1936 he was made director of organic chemical research for U. S. Industrial Chemicals, Inc., and from 1951 to 1952 was a research staff member of the Office of Synthetic Rubber, Washington, D. C. After retiring as a director from U.S.I.C., he joined the staff at the University of Southern California as a professor of chemical engineering and director of the TLARGI Rubber Technology Foundation. He retired for the second time in October, 1956.

Synthetic Fibers

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THE RATE OF GROWTH of the synthetic fiber industry exceeds that of any other major division of the petrochemical industry. Nylon, the first of the chemical fibers, was introduced to the trade by Du Pont in 1939 and found such ready acceptance that 10 million pounds were sold in the following year. Sales of all synthetic fibers in 1956 were approximately 500 million pounds, representing a fifty-fold increase in 16 years. While the different synthetic fibers vary widely in price depending upon composition, type, and size, the weighted average price of all such fibers sold today is approximately $1.40 per pound. Based on the current consumption of synthetic fibers, as well as the quantity of chemicals required to convert them to fabrics and finished garments, the industry can be said to be a billion dollar one.

According to estimates made by the President's Materials Policy Commission, the production of synthetic fibers should increase to 1¼ billion pounds during the next five years, and to 4 billion pounds by 1975. This will include 1.2 billion pounds of acrylic fibers, 800 million pounds of nylon, 1 billion pounds of polyester fibers, and 1 billion pounds of other types of synthetic fibers.

The per capita consumption of all fibers is approximately 40 pounds annually, and this is expected to increase at a very slow rate with time. The corresponding consumption of synthetic fibers is 2.8 pounds, and this is increasing at a much more rapid rate.

In the textile industry, an important trend is the increasing demand for garments requiring minimum care, such as wash-and-wear trousers. This has encouraged the use of increasing amounts of synthetic fibers which, due to their hydrophobic characteristics, possess good wrinkle-resisting and crease-retention properties. In other applications, such as in carpets, the outstanding resiliency of certain synthetic fibers are creating new standards of style and durability.

In industrial applications, the trend is toward the development of fibers and yarns having improved performance characteristics. This includes the use of high-tenacity nylon yarns for tire cord; the development of sunlight-resisting yarns for awnings, drapes, and upholstery; and the development of stabilized fibers for high-temperature and corrosive applications.

New developments, which should have an important effect upon the growth of the synthetic fiber indus-

try, include the increasing use of nonwoven procedures for the production of fabrics, the development of texturizing processes for improving the hand and appearance of fabrics derived from continuous filament yarns, and the use of synthetic fibers as reinforcing agents for plastic sheets and films.

Substantially all of the synthetic fiber plants are located in the South due to the availability of the petrochemicals used as raw materials for their production. In addition, over half of the textile mills in the country are located in the same area.

About the Author

Frank Soday is vice president in charge of research and development for Chemistrand Corporation, Decatur, Ala. Previously he was director of research and development for Lion Oil Company, and for Devoe & Reynolds Company, Inc. During World War II he was technical director for Copolymer Corporation which operated the government synthetic rubber plant at Baton Rouge.

A native of Coaltown, Penn., Soday received his B.S. degree in chemical engineering at Grove City College in 1929, and his M.S. and Ph.D. degrees from Ohio State University in 1931 and 1932 respectively. Soday holds more than 130 U. S. patents, and is a member of numerous technical societies.

Synthetic Detergents

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IN 1957, synthetic detergent or syndet sales have continued to advance at the expense of soap, but only slightly in comparison with recent years. For example in 1956, syndet sales went up 16 percent in tonnage over the previous year, while soap sales were off 5 percent. In the first half of 1957 syndet sales increased only 2 percent over that of the same period of the previous year, while correspondingly, soap sales fell off 9 percent. Sales figures are shown in Table 1.

The most notable change is in the increase in sales of liquid syndets, an increase which started a year or so ago and continued strongly into this year. The light-duty or unbuilt liquid syndets are becoming so popular for hand dishwashing that they have cut noticeably into granular syndet sales. Heavy-duty or built liquid products for home laundering have also been introduced, and in time may be as well received for the laundry as the light-duty liquids are for dishwashing. Advantages are, immediate solubility and easy rinsing. The heavy-duty liquids, like the granules, contain dodecyl benzene sulfonate, and are built with sodium or potassium silicate and carboxy methyl cellulose. Instead of the usual sodium tripolyphosphate builder, however, they contain the more soluble tetrapotassium pyrophosphate.

The light-duty products are heavy foamers—usually made so by inclusion of a complex amine—while in the heavy-duty products, high foaming is not essential. In fact, liquids might well be made to be competitive with the low-foamers, especially designed for automatic washing machines.

The alkyl aryl sulfonates, largely based on petroleum fractions, continue in large production, but have been put in a more competitive position by various nonionics. Sodium dodecyl benzene sulfonate has fallen from its peak of about 80 percent of syndet production to about 50 percent. Benzene, one of the raw materials in this product, is now obtained in specification grade roughly as follows: 30 percent from petroleum, 60 percent from coke ovens and 10 percent from imports.

The major part of the nonionics are still based on petroleum-derived ethylene oxide condensation products. New nonionics continue to be offered for special industrial applications. More and more industries are finding stages in their processing of materials where increased wetting power means better results. Nonionics are still necessarily more expensive than dodecyl benzene sulfate, which is produced efficiently on such a vast scale. The sugar esters, nonionics low in raw material costs, are being produced commercially. Because of their nontoxic nature they are especially suitable for food processing and in cosmetic and drug preparations.

Syndets have successfully invaded the last stronghold of soap, the toilet-soap field. Each of the three big soap companies is making a syndet bar. Two of these contain some proportion of soap to give the desired plastic physical properties so difficult to get with syndet alone. One is on widespread sale to the public.

Research and technical studies continue in the syndet field, to produce products more satisfactory to the consumer and therefore to meet or overcome competition.

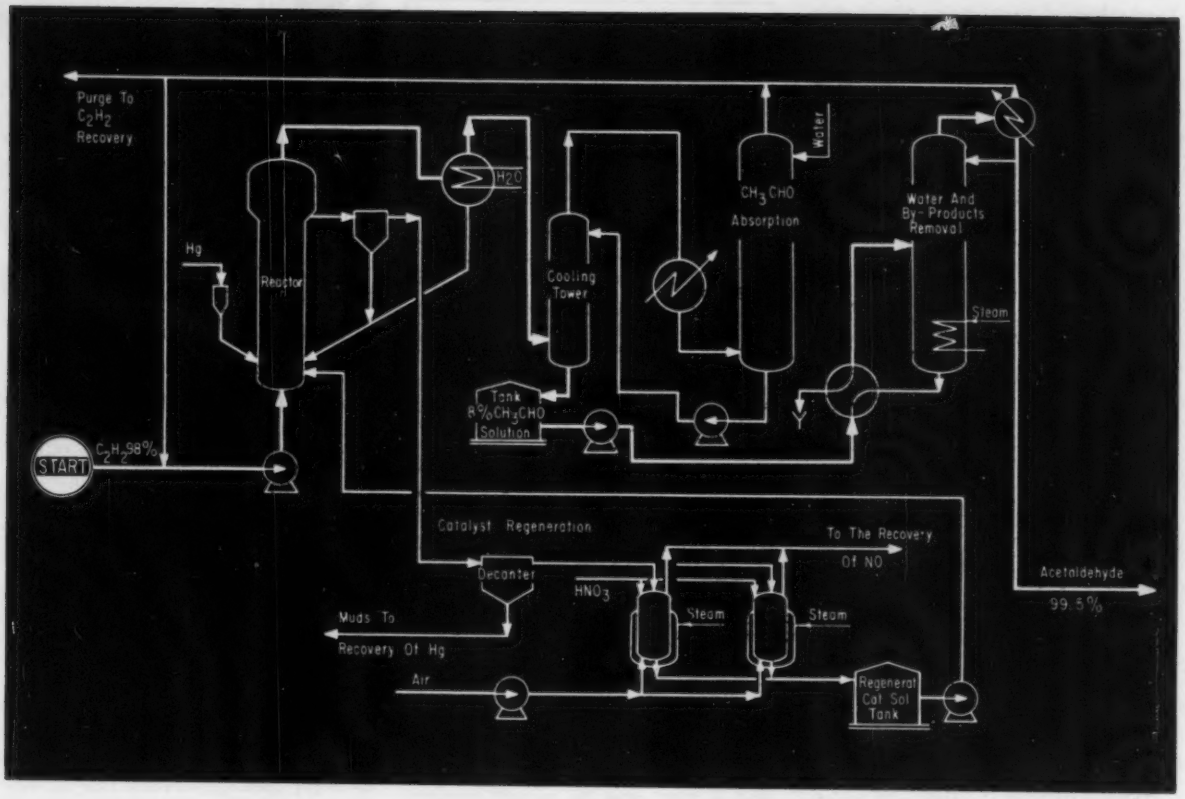
TABLE 1—Sales—First Half of 1957*

	Pounds (Thousands)	Percent Change From 1st Half, 1956	Dollars (Thousands)	Percent Change From 1st Half, 1956
Solid Soaps	572,991	— 9.2	150,071	+ 0.01
Solid Syndets	1,241,965	— 0.3	264,537	+ 6.0
Liquid Soaps	16,888	— 8.9	3,230	—20.1
Liquid Syndets	161,592	+24.2	59,111	+11.3

* Furnished by the Association of American Soap & Glycerine Producers.

About the Author

Foster Dee Snell was born in Binghamton, N. Y. He received a B.S. degree from Colgate University in 1919, an A.M. degree from Columbia University in 1922, and a Ph.D. degree from Columbia in 1923. In addition to being president of Foster D. Snell, Inc., and Foster D. Snell Foundation, Inc., he still manages to devote a tremendous amount of his time and effort to other activities. He is a member of numerous honorary clubs and fraternities, and more than a dozen scientific organizations, in many of which he has held or still holds some office. Snell has published over 60 articles, six books, and holds more than 30 patents.



Acetaldehyde—MONTECATINI

Application: A process for manufacturing acetaldehyde by means of catalytic hydration of acetylene.

Charge: Acetylene at 98 percent.

Product: Acetaldehyde at 99.5 percent purity.

Description: Acetaldehyde is produced by direct hydration of acetylene, according to the reaction:

$$CH : CH + H_2O = CH_3 \cdot CHO$$

This reaction, catalyzed by mercuric ion, takes place by injecting acetylene in a mercuric sulphate solution acidified by sulphuric acid. The produced acetaldehyde has a trend to oxidize in acetic acid, thus reducing the mercuric ions to metallic mercury, according to the reaction :

$$CH_3 \cdot CHO + H_2O + Hg^{++} = CH3 \cdot COOH + Hg + 2H^+$$

As a consequence of this reaction, the mercuric ion, catalytically active, transforms itself into metallic mercury which has no longer a catalytic action: to prevent metallic mercury precipitation and to re-oxidize it to mercuric ion, ferric sulphate is added to the catalytic solution. Mercury oxidation takes place by reducing ferric ion to ferrous ion: by consequence, it is necessary to constantly extract a part of the catalytic solution for regenerating the ferric sulphate.

The catalyst solution is constantly drawn and sent to regeneration, after the removal of muds containing mercury : said muds are periodically hot-treated to recover metallic mercury.

The regeneration of catalytic solution consists of an hot-treatment with nitric acid in presence of air which is blown in the solution. There is a production of nitrogen oxide while ferrous ion oxidizes itself to ferric ion.

The so regenerated solution is sent back to the hydration reactor. The reactor operates adiabatically and the residence time of acetaldehyde in the catalytic solution is so calculated to minimize secondary reactions.

Acetaldehyde vapours mixed with steam and unreacted acetylene overflow from the top of the reactor. The mixture is then cooled in three subsequent stages. In a first cooler the temperature is lowered down to about 60 C; practically only water condensates and is sent back to the reactor. Then, the gaseous mixture is admitted into a cooling tower where it is washed by the 8 percent acetaldehyde solution outflowing from the absorption tower. At the cooling tower outlet the gaseous mixture is cooled again down to 30 C in a last surface cooler and is subsequently conveyed to the absorption tower for the recovery of the acetaldehyde as water solution.

Unreacted acetylene, mixed with the inert gases contained in the starting acetylene, outflows from the top of this tower and is sent back to the reactor, while a small part of it is continuously purged. The purged gases, containing acetylene, are sent back to acetylene recovery which can be carried out by conventional means: in case the acetaldehyde unit is coupled to a methane cracking unit for the production of acetylene, the purged gases are sent to the main raw acetylene gasholder; they subsequently follow the concentration process of the acetylene production unit.

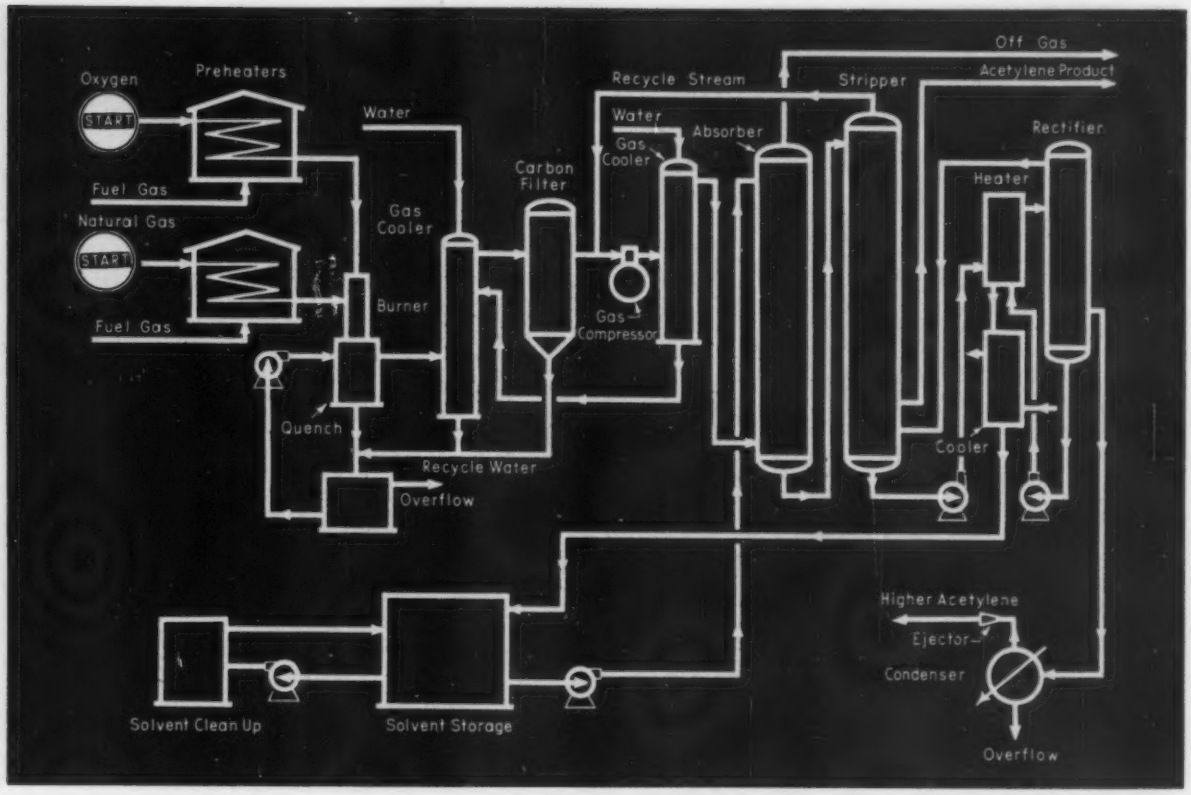
From the bottom of the absorption tower, acetaldehyde solution at 8 percent concentration is obtained, it is subsequently sent to the cooling tower and then to the collecting tank. From the collecting tank the solution is pumped through a pre-heater to a distillation tower, from the top of which acetaldehyde at 99.5 percent is obtained by condensation.

The small acetylene quantity developed during acetaldehyde condensation is recycled back to the reactor. From the bottom of this tower a mixture consisting of water and by-products is continuously drained off.

Operating Conditions: The reactor operates at a temperature of about 85 C and the plant is run at about atmospheric pressure.

Yields: The total yield of acetaldehyde is 95 percent based on the consumption of acetylene.

Commercial Installations: A large industrial plant is in operation at the Montecatini Works of Novara, Italy.



Acetylene (BASF)—CHEMICAL CONSTRUCTION CORPORATION

Application: A process for making acetylene.

Charge: Natural gas; oxygen, 90-95 percent purity.

Product: Acetylene of 99+ percent purity.

Description: Oxygen and natural gas are preheated separately in direct-fired heaters to about 1200 F. The charge gases are mixed in a molar ratio of 0.60:1.00 oxygen:methane upon being fed to the converter. The converter is a vertical cylindrical unit comprising three sections: mixing chamber, flame room, and quench chamber. The mixing chamber is specially designed to provide rapid yet thorough mixing of oxygen and methane.

The mixed gases are fed to the flame room through a plurality of ports in a burner block designed to prevent backtravel or blowoff. In the flame, methane is cracked according to the endothermic reaction:

$$2CH_4 \rightarrow C_2H_2 + 3\,H_2$$

The combustion of methane supplies sensible and cracking heats. About one-third of the entering methane is cracked; most of the remainder is burned. Over-all conversion of methane is 90-95 percent; conversion of oxygen is complete. The flame reaches an average temperature of 2700 F. Operating pressure is slightly above atmospheric. Residence time is 0.001-0.01 seconds.

The acetylene is cooled rapidly by a series of sprays located in the lower part of the converter. The cooled gases pass directly to a spray chamber where most of the water is condensed. The gases leave the chamber at 100 F. and have the following typical composition (dry basis):

Acetylene	8.5 percent
Hydrogen	57.0 percent
Carbon monoxide	25.3 percent
Carbon dioxide	3.7 percent
Methane	4.0 percent
Higher Acetylenes	0.5 percent
Inerts	1.0 percent
Total	100.0 percent

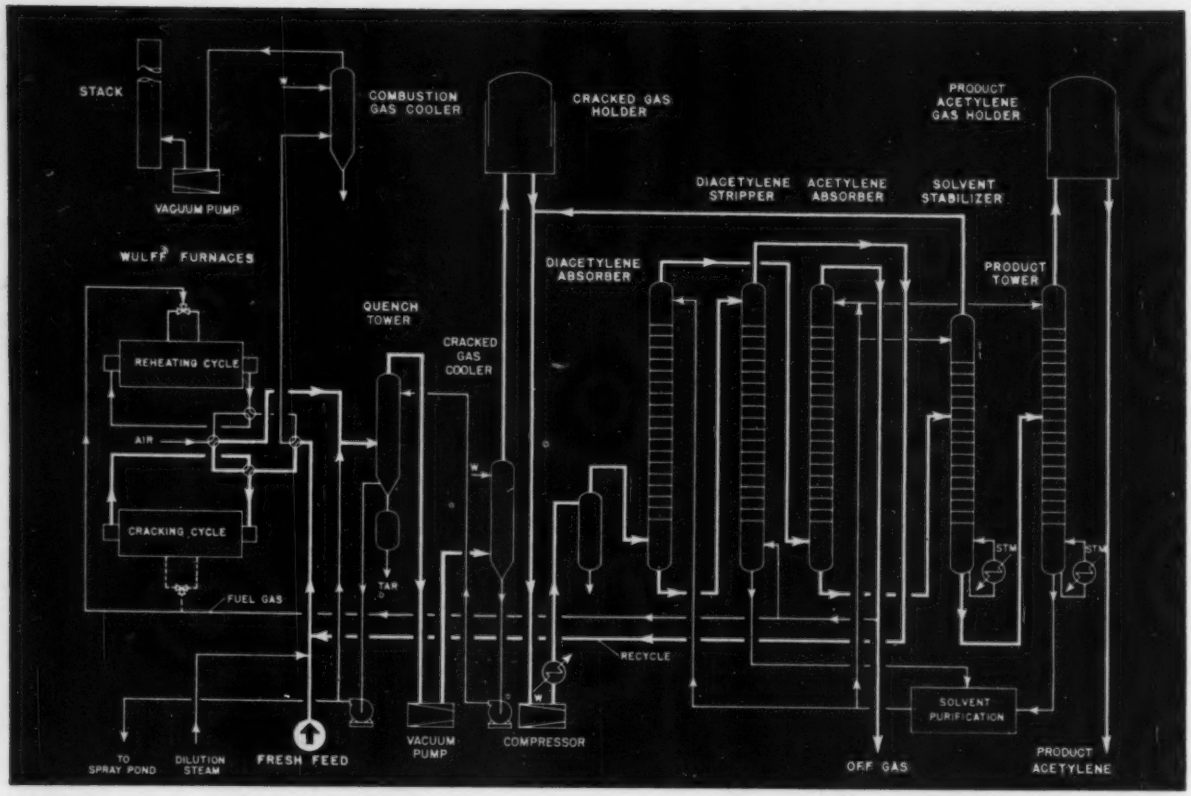
Before the cracked gas can be compressed and separated, residual soot must be removed. The clean cracked gas is then compressed to the head pressure (165 psig) of the concentration system.

The cracked gas passes from the compressor to the main absorber, where acetylene is removed by a selective solvent which shows a high acetylene: carbon dioxide selectivity. Carbon dioxide is removed from the rich solvent by a flashing and stripping operation. Acetylene is stripped from the solvent by conventional flashing and fractionation. Higher acetylenes and water are removed by stripping under reduced pressure. The product acetylene has a purity of 99+ percent with major impurities being methylacetylene, propadiene and carbon dioxide.

Yields: The over-all process yield of acetylene, based on carbon in the natural gas, is 30 percent.

Commercial Installations: This process or a variation is used by Carbide and Carbon Chemicals Company, Texas City, Texas (currently being expanded), Monsanto Chemical Company, Texas City, Texas; American Cyanamid Company, Fortier, La. (currently being expanded); Rohm and Haas Company, Deer Park, Texas (under construction).

Reference: PETROLEUM REFINER, Dec.'54,p160.



Acetylene (Wulff)—THE LUMMUS COMPANY

Application: A process for manufacturing acetylene.

Charge: Hydrocarbons ranging from methane through gas oil.

Product: Acetylene of high purity.

Description: The Wulff Acetylene process employs a regenerative furnace to attain the high temperatures required to crack hydrocarbon gases to acetylene. The furnace consists of a long box filled with refractory checker bricks except for a center section where fuel gas is admitted and mixed with combustion air.

The Wulff furnace operates on a four-phase cycle. First, air is drawn into the furnace at one end where it is preheated by contact with hot checkers before meeting fuel gas introduced at the center of the furnace. The hot combustion gases heat up the checkers through which they pass on leaving the other end of the furnace. The hydrocarbon charge stock, diluted with steam, then is admitted at that end of the furnace where the checkers have just been heated by combustion gases. The charge is cracked in this section. Then heat is recovered from the cracked products as they pass through the cooler side of the furnace. These two operations are repeated in the reverse direction to complete the cycle.

Operation of the furnace on a four-phase cycle is made possible by a cycle-timer operating interlocked four-way plug-type switch valves. Continuous production of cracked gas is achieved by installing Wulff furnaces in pairs.

During the heating period, the products of combustion leaving the furnace are cooled, sent to the combustion gas vacuum pump, and discharged to a stack. The cracked gas from the furnace passes to a quench system for condensation of most of the dilution steam and the small amount of liquid products and tars formed in the cracking operation. The remaining gas is compressed to atmospheric pressure by the cracked-gas vacuum pump, is cooled and flows to the cracked gas holder.

In some applications, it will be found advantageous to return unconverted hydrocarbons and by-product materials to the pyrolysis step to increase ultimate yield. The recovery unit is accordingly designed to produce a recycle stream which can be charged to the furnaces together with the fresh feed and the dilution steam.

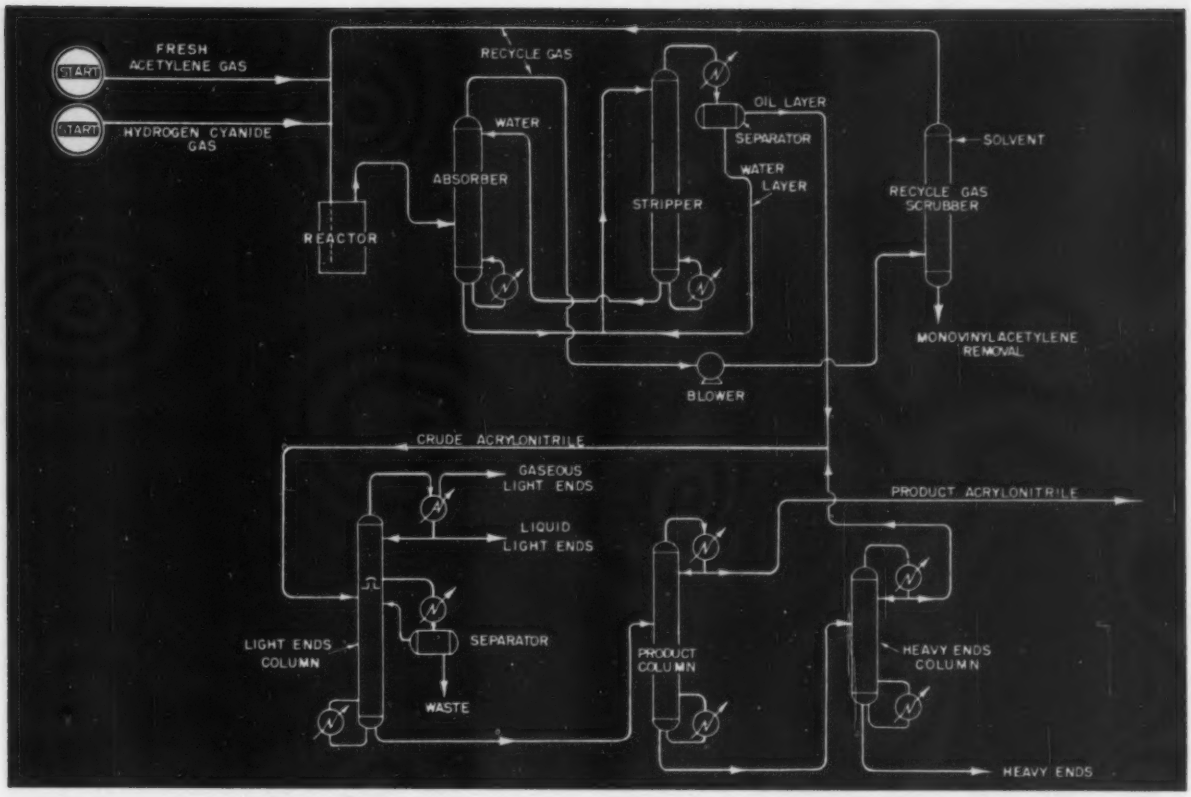
Recovery of the acetylene from the cracked gas is accomplished by any one (or a combination) of several well-known methods for the separation of low molecular weight hydrocarbons. Low temperature fractionation and absorption with various selective solvents have been employed commercially. The recovery unit of the Wulff demonstration plant is a selective absorption gas plant which is operating currently with dimethyl formamide as the solvent.

The extremely reactive diacetylene is first removed from the cracked gas and this is followed by absorption of the acetylene and more soluble components. A final separation is made between the acetylene and any contaminants which are also absorbed in the solvent. The experience obtained with dimethyl formamide has shown it to have excellent capacity and selectivity for the recovery of acetylene from Wulff cracked gas. The choice of design of the recovery unit for commercial scale Wulff plants is dictated largely by the end use of the product acetylene.

Yields: The Wulff process can be operated using hydrocarbons ranging from methane through gas oil, and their blends, as charging stock for the production of acetylene. These operations may be tailored to produce ethylene (and higher olefins) as by-products. The process may be operated on a once-through or on a recycle basis. The yield obtained is dependent upon the raw material, product distribution, and operation employed.

Commercial Installations: Los Angeles demonstration plant of the Wulff Process Co., producing acetylene in cylinders for welding purposes.

References: PETROLEUM REFINER, Sept.'53,p162; *Chemical Engineering Progress,* p372, July 1954.



Acrylonitrile

Application: A process for manufacturing acrylonitrile from acetylene and hydrogen cyanide.

Charge: Acetylene gas (99 percent purity); hydrogen cyanide gas (99+ percent purity).

Product: Acrylonitrile liquid of 99.5 percent purity.

Description: Acrylonitrile may be produced either by the dehydration of ethylene cyanohydrin or by the direct combination of acetylene and hydrogen cyanide. The latter method is known as the "natural gas process." It is the more important method today, commercially, and accordingly will be described here.

Acetylene and hydrogen cyanide in a ratio of 10:1 form the reactor charge. The reactor is a rubber-lined cylindrical vessel containing liquid catalyst to a depth of several feet. The reactants are injected separately under the liquid surface. About 10 percent of the acetylene is converted, and this consumes practically all of the hydrogen cyanide.

The aqueous catalyst consists of cuprous chloride, hydrogen chloride, and alkali chlorides in 36 weight percent water. All salts are in solution at 175 F. which is also the reaction temperature. Yields of 1.0-1.5 pounds of acrylonitrile per hour-foot^3 of solution are obtained. The catalyst life is 1-2 months and must be regenerated.

The reaction pressure is slightly above atmospheric.

The reaction products pass to an absorber, the lean gas from which contains acetylene and divinylacetylene. The latter constituent is removed in a separate scrubbing operation. The residual acetylene is recycled through a blower to the reactor charge.

The absorber is operated at a water rate such that a two percent acrylonitrile solution is withdrawn as bottoms. This stream is sent to the stripper, from which a crude acrylonitrile-water azeotrope is taken overhead. The water layer from the separated azeotrope is recycled to the stripper feed. The oil layer, or "crude acrylonitrile," is sent to a distillation train for separation and purification.

The concentration of acrylonitrile in the crude solution is about 80 weight percent; that of the other materials is four weight percent or less.

The first tower in the distillation train (light ends column) enables the overhead removal of materials boiling below acrylonitrile. Acetylene and monovinylacetylene pass off as gases.

Product acrylonitrile, having a purity of about 99.5 percent on a dry basis, is removed as overhead from the second column. The operating head pressure is about 140 mm Hg abs. The bottoms stream contains heavy ends plus a significant amount of acrylonitrile.

The third tower in the train, the heavy ends column, serves to recover acrylonitrile from the product column bottoms. The heavy ends column operates at a head pressure of 120-150 mm Hg abs. The recovered acrylonitrile is not specification-grade and must be recycled to the light ends column.

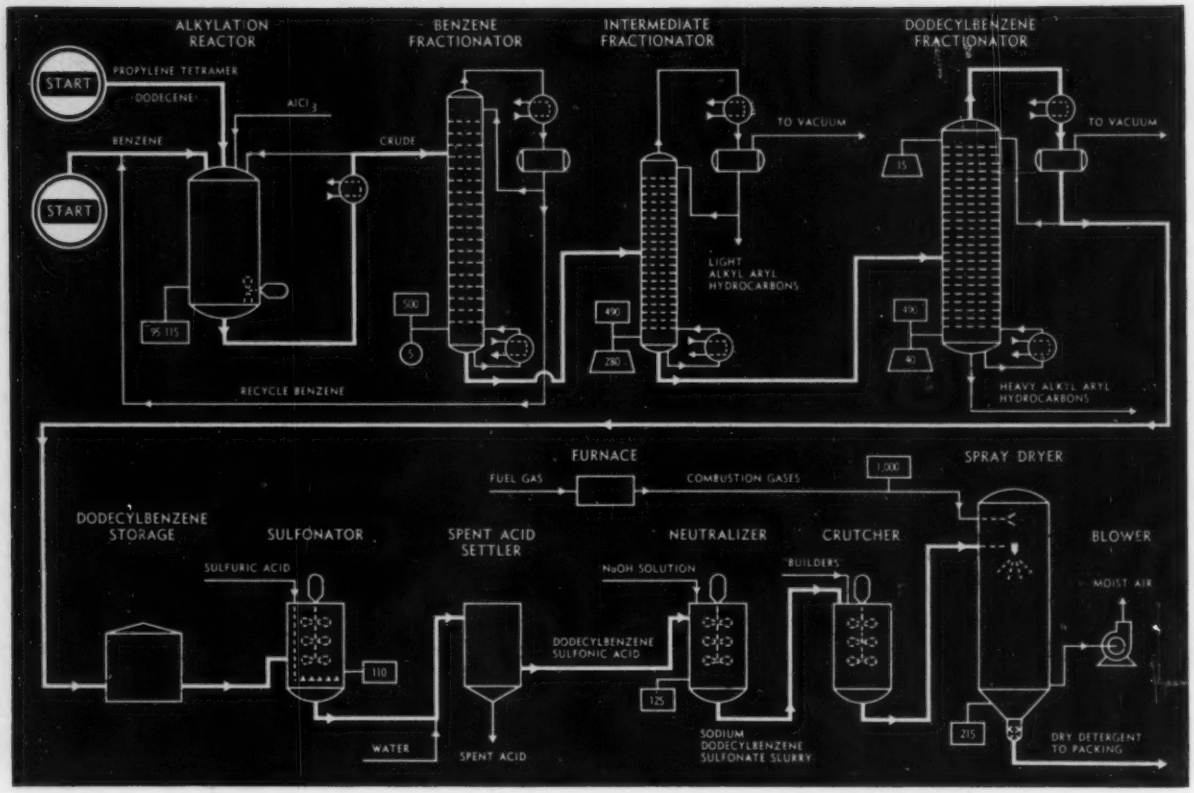
The product acrylonitrile has a boiling range of 169-173 F.

Operating Conditions: The important operating conditions are those in the reactor. They are defined in the above text.

Yields: Typical over-all process yields are:
Acrylonitrile from HCN, 85 percent.
Acrylonitrile from C_2H_2, 75 percent.

Commercial Installations: Plants utilizing the methane process are: Monsanto Chemical Company, Texas City, Texas; American Cyanamid Company, Fortier, La.; The B. F. Goodrich Company, Calvert City, Ky.

References: "The Manufacture of Acrylonitrile From Natural Gas," J. T. Thurston, E. L. Carpenter, and F. Derbenwick of American Cyanamid Co., Fourth World Petroleum Congress, Rome, Italy.



Alkyl Aryl Sulfonates—CONTINENTAL OIL COMPANY

Application: A process for the manufacture of dodecylbenzene sulfonate synthetic detergents.

Charge: Benzene, dodecene (propylene tetramer), sulfuric acid, caustic soda, and "builders."

Product: Finished detergent containing 15 to 40 percent sodium dodecylbenzene sulfonate.

Description: This process involves reaction of dodecene with benzene in the presence of aluminum chloride catalyst; fractionation of the resulting crude mixture to recover the desired boiling range dodecylbenzene; sulfonation of the dodecylbenzene and subsequent neutralization of the sulfonic acid with caustic soda; blending the resulting slurry with chemical "builders"; and drying.

Dodecene (350-420 F. boiling range) is charged into a reaction vessel containing benzene and aluminum chloride. The reaction mixture is agitated and circulated through an external cooler to maintain the reaction temperature at about 115 F. maximum. An excess of benzene is used to suppress the formation of by-products. Aluminum chloride requirement is 5-10 weight percent of dodecene. The reaction may be carried out using hydrofluoric acid or sulfuric acid in place of aluminum chloride.

After removal of aluminum chloride sludge, the reaction mixture is fractionated to recover excess benzene which is recycled to the reaction, a light alkylaryl hydrocarbon, dodecylbenzene, and a heavy alkylaryl hydrocarbon. The dodecylbenzene is a water-white liquid having a boiling range of 530-600 F.

Sulfonation of the dodecylbenzene may be carried out continuously or batch-wise under a variety of operating conditions using sulfuric acid (100 percent), oleum (usually 20 percent SO_3) or anhydrous sulfur trioxide. The optimum sulfonation temperature is usually in the range of 100-140 F. depending on the strength of acid employed, mechanical design of the equipment, etc. Removal of spent sulfuric acid from the sulfonic acid is facilitated by adding water to reduce the sulfuric acid strength to about 78 percent. When anhydrous sulfur trioxide is the sulfonating agent, there is no spent acid removal problem and the sulfonic acid is ready for further processing immediately after sulfonation.

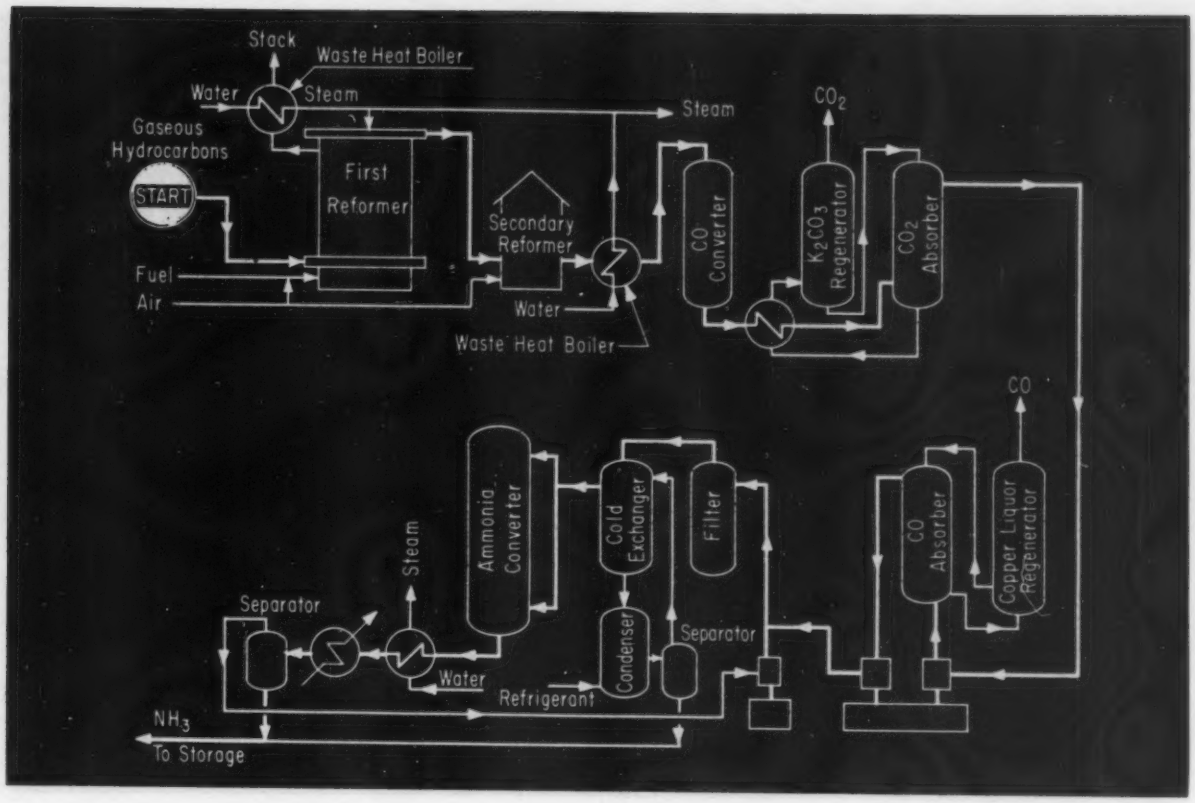
The sulfonic acid is neutralized with 20-50 percent caustic soda solution to a pH of 8 at a temperature of about 125 F. Chemical "builders" such as trisodium phosphate, tetrasodium pyrophosphate, sodium silicate, sodium chloride, sodium sulfate, carboxymethyl cellulose, etc., are added to enhance the detersive, wetting or other properties desired in the finished product. A flaked dried product is obtained by drum drying, or a bead product is obtained by spray drying.

Operating Conditions: Refer to the above text and flow diagram.

Yields: Alkylation, 75 percent; sulfonation, substantially 100 percent; drying, 95 percent or greater.

Commercial Installations: Continental Oil Company, Baltimore, Md., and Chicago; Atlantic Refining Company, Philadelphia, Pa.; Oronite Chemical Company, Richmond, Calif.; Monsanto Chemical Company, St. Louis, Mo., and Standard Oil Company of Indiana, Whiting, Ind.

References: PETROLEUM REFINER, July, 1954, p. 157; *Ind. Eng. Chem.*, **46**, 1925 (1954); *Ind. Eng. Chem.*, **46**, 248 (1954); *J. Am. Oil Chemists' Soc.*, 31, 200 (1954).



Ammonia—CHEMICAL CONSTRUCTION CORPORATION

Application: This is a process for the manufacture of ammonia.

Charge: The feed to the process may be any mixture of gaseous hydrocarbons below hexane consisting primarily of saturates, or acetylene off-gas, or a mixture of hydrocarbons and off-gas.

Description: The feed gases are reformed by reaction with steam at any pressure up to 300 psig. The optimum pressure is selected for the particular gas to be processed. The process steam required is generated in waste heat boilers.

Most of the hydrocarbons are reformed to hydrogen, carbon monoxide and carbon dioxide in the primary reformer. Heat for the reaction is supplied by a fuel such as natural gas or, fuel oil.

The reactions are completed in the secondary reformer. The necessary heat is supplied by reaction of combustible products with oxygen in air. The correct amount of nitrogen to form a 3:1 Hydrogen-Nitrogen ratio enters with the air.

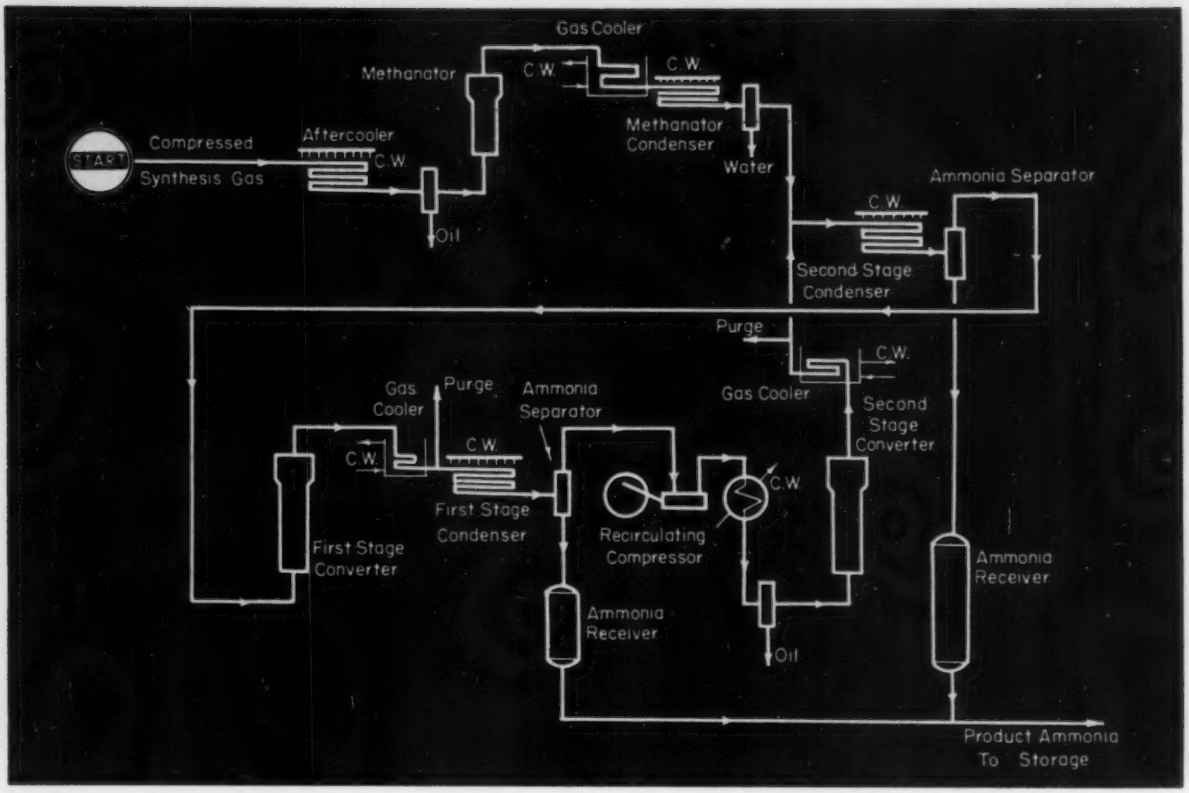
Most of the carbon monoxide formed by reforming is converted to carbon dioxide in the carbon monoxide converter, by reaction of carbon monoxide with steam to form hydrogen and carbon dioxide.

The reformed gas is purified as follows:
Carbon dioxide is removed by scrubbing with hot potassium carbonate solution at about 250 psig. If the reforming pressure is below 250 psig the gas passes through one stage of compression before carbon dioxide removal. Residual carbon monoxide is removed by scrubbing with cold copper liquor at 2000 psig.

After purification the gas is compressed to 5200 psig and synthesized to ammonia by the well known NEC Process as illustrated in the flow diagram. Production of steam in the synthesis loop is optional depending on economic considerations for a particular plant.

Products: The primary product is anhydrous liquid ammonia with a minimum purity of 99.9 percent. Other products are carbon dioxide and carbon monoxide. The carbon dioxide is of sufficient purity to be used for the production of dry ice or urea. The carbon monoxide may be used as supplemental feed to a methanol plant.

Commercial Installations: There are domestic and foreign installations of the NEC Process for ammonia synthesis in operation all over the world.



Ammonia (Claude Process)

Application: The Claude process for the manufacture of ammonia.

Charge: Synthesis gas—approximately 75 mole percent hydrogen, 25 mole percent nitrogen.

Product: Technical grade ammonia (99.5 percent purity).

Description: The synthesis gas is compressed to 15,000 psi, cooled to ambient temperature, and passed through a separator for removal of compressor lubricating oil. It is then charged to the methanator reactor, where carbon monoxide is converted according to the reaction

$$CO + 3H_2 = CH_4 + H_2O$$

A reduced iron catalyst (previously used in the ammonia converters) is used. The methanator reactor is a steel vessel containing a catalyst basket and means for internal heat exchange between inlet and exit gases. Typical operating conditions are: pressure, 15,000 psi; temperature in reaction zone, 730-930 F. (depending on age of catalyst); vapor space velocity, 60,000 $hr.^{-1}$ Catalyst life is on the order of six months.

The methanator effluent is cooled from 300 F. to ambient temperature, which causes condensation of water and small amounts of methanol and methylamine produced in the methanator. These materials are removed in a separator, and the gas is then ready for admission to the synthesis loop. It contains hydrogen and nitrogen in a 3.0:1.0 ratio, and some 2.0-2.5 percent inert gases.

The synthesis loop comprises two ammonia converters with attendant condensers and separators, a reciprocating compressor for circulating the gases around the loop, and a purge system for controlling the level of inerts.

The fresh synthesis gas from the methanator is introducted downstream of the second-stage ammonia converter (other points of introduction can be used) before the gases from that converter have been cooled. The mixture passes to a water-cooled condenser where some 60 percent of the ammonia present is condensed. The condensate is trapped out to low pressure receivers and ultimately finds its way to product ammonia storage. The non-condensed material comprises the feed to the first-stage ammonia converter.

The first-stage converter is a specially-designed vessel with steel shell and closure, and certain internals of high-nickel alloy. The catalyst is a special magnetic iron oxide, doubly promoted with aluminum and potasium oxide, and reduced *in situ*. The gases make several passes through the internals for the double purpose of keeping the outer shell cool and exchanging heat between products and reactants. Electric heating coils are provided for starting up the converter. The catalyst basket is designed for convenient removal from the reactor shell, since the catalyst life is on the order of 2-3 months.

Typical operating conditions for the first-stage converter are: pressure, 14,500-14,700 psi; temperature in reaction zone, 900-1100 F. (depending on age of catalyst); vapor space velocity, 44,000 $hr.^{-1}$; and conversion per pass, 40 percent. The exit gas from the converter has a temperature of 300-350 F.

About 80 percent of the ammonia in the exit gas is condensed in a water-cooled exchanger, and trapped out to product storage. The uncondensed material passes to the recirculating compressor where the pressure is boosted by 500-1000 psi. The discharge gas is cooled, oil is removed, and the gas fed to the second-stage converter.

The second-stage converter is similar in design to the first-stage unit, and operates under the following conditions; pressure, 15,000-15,500 psi; temperature in reaction zone, 900-1100 F. (depending on catalyst age); vapor space velocity, 30,000 $hr.^{-1}$; conversion per pass, 40 percent. The exit, gas, at a temperature of 280-330 F., is mixed with fresh synthesis gas and the cycle repeated.

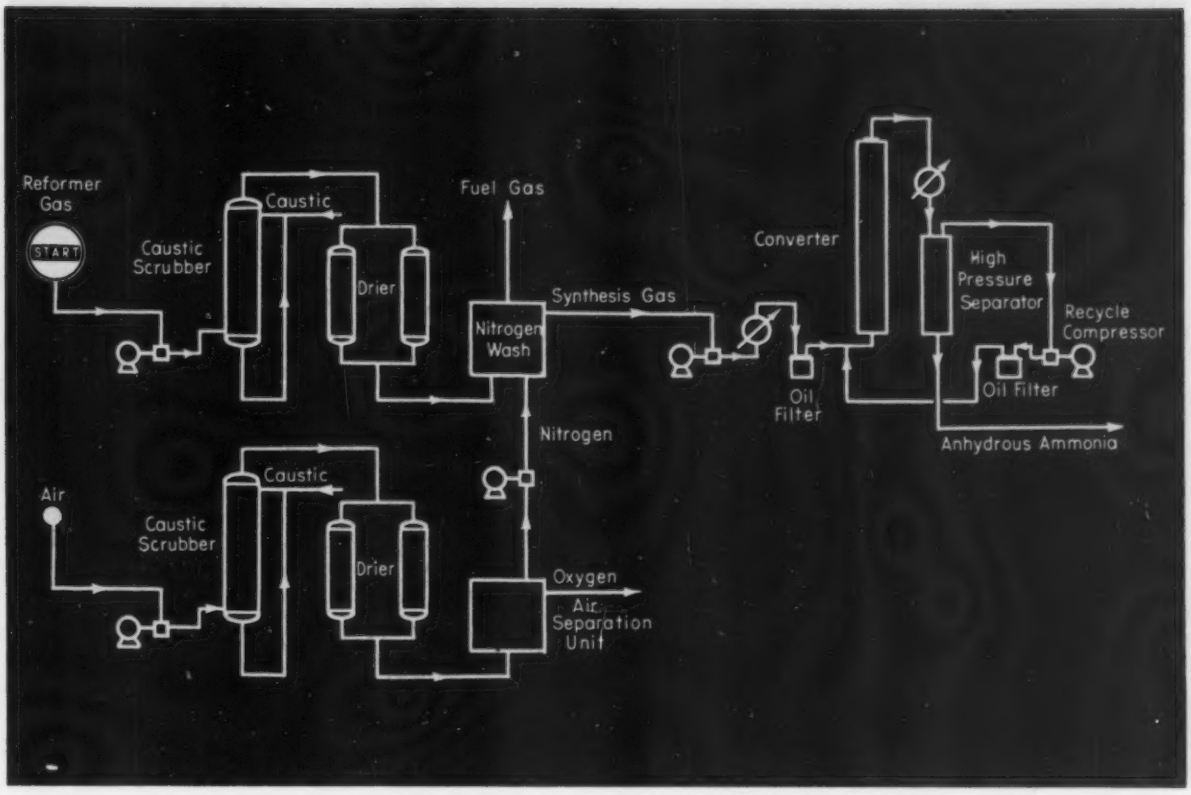
A buildup of inert gases is prevented by bleeding off a portion of the exit gases from the converters.

The condensed ammonia from the converter exit streams is depressured and stored in steel spheres at about 55 psig and 38 F.

Yield: Over-all process yield, ammonia from synthesis gas, is 85-87 percent.

Commercial Installations: This process is used at the following plants: Hercules Powder Co., Pinole, Calif.; Mississippi Chemical Corp., Yazoo City, Miss,; Mississippi River Fuel Corp., Crystal City, Mo.; San Jacinto Chemical Co., Houston.

Reference: Thompson, H. L., P. Guillaumeron and N. C. Updegraff, *Chem. Eng. Progr.*, 48,468(1952).



Ammonia—THE FLUOR CORPORATION, LTD.

Application: A process for manufacturing ammonia.

Charge: Catalytic Reformer Off-Gas.

Product: Liquid Anhydrous Ammonia.

Description: Briefly, the complete process scheme involves the following steps: (1) Separation of air into nitrogen and oxygen; (2) purification of the hydrogen; and (3) synthesis of ammonia from the hydrogen and nitrogen mixture.

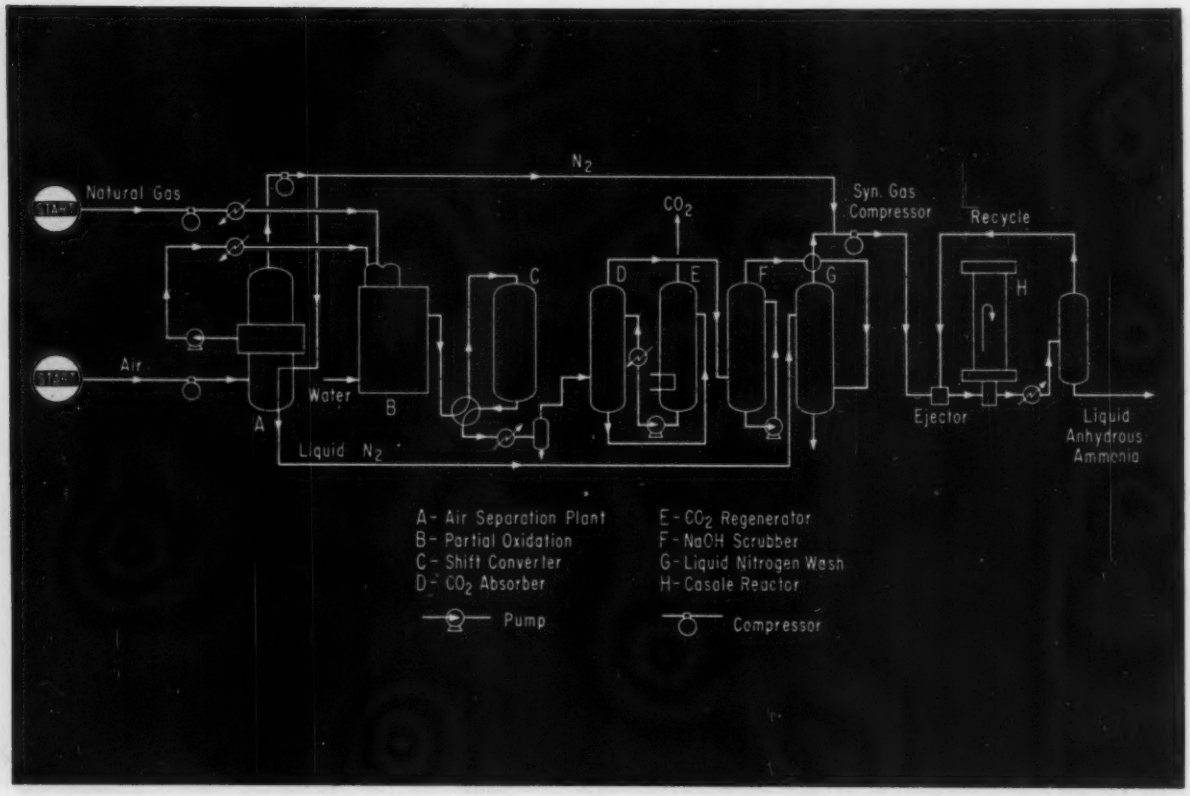
As shown in diagram, air is compressed, scrubbed with caustic for carbon dioxide removal and then dried. The air is separated by liquefaction and distillation into nitrogen of 99.99 percent purity and oxygen of 85 percent purity. This oxygen is available as a by-product but in this presentation is treated as a waste gas. A high hydrogen-treated content catalytic reformer off-gas such as may be obtained from a fixed-bed, nonregenerable platinum-catalyst unit has been assumed as feed. The assumed analysis is hydrogen, 93.0 and hydrocarbons, 7.0 vol. percent. The gross heating value is 490 BTU/std. cubic foot. In view of the high hydrogen concentration and low acid-gas concentration, the purification of this reformer gas is very easily accomplished by a light caustic scrub, low temperature condensation of most of the hydrocarbons and then nitrogen wash to remove traces of methane and any carbon monoxide. Part of the synthesis nitrogen is supplied by vaporization of liquid nitrogen in the nitrogen wash unit. Additional nitrogen from the air separation unit is added to the hydrogen to make the synthesis-gas mixture.

The synthesis-gas mixture consists of 3 parts hydrogen, 1 part nitrogen, about 100 ppm inerts, and less than 20 ppm total oxygen-containing impurities. The synthesis-gas mixture is compressed to about 600 atm. and filtered for oil removal. It is very important that all of the oil be removed from the synthesis gas stream before it goes to the ammonia converter. The oil, if not removed, can contaminate the catalyst and reduce its life. The activity of the catalyst is reduced rather rapidly by poisons carried over in the compressor lube oil. At the inlet to the ammonia converter, the fresh feed is joined by a recycle stream of unconverted hydrogen and nitrogen. The combined feed stream is heated inside the ammonia converter by heat exchange with product gases. The hot hydrogen-nitrogen mixture passes through a bed of promoted iron catalyst, where conversion to ammonia occurs. Effluent gases from the converter are cooled by exchange with water, and product ammonia is condensed and separated from the unconverted gases in a high-pressure separator. The ammonia is sent directly to storage and the hydrogen and nitrogen are recycled by means of the recycle compressor.

Operating Conditions: The synthesis converter operates at about 600 atmospheres.

Commercial Installations: Several units of this type are under construction.

References: PETROLEUM REFINER, Dec.'54,p156 and May'55,p145.



Ammonia—FOSTER WHEELER CORPORATION

Application: A process for manufacturing ammonia.

Charge: Natural gas and air.

Product: Liquid Anhydrous Ammonia.

Description: The processing sequence for the synthesis of ammonia comprises six steps: air fractionation, partial oxidation, shift conversion, carbon dioxide removal, liquid nitrogen wash and ammonia synthesis.

Air, filtered and caustic scrubbed, is compressed to approximately 600 psig, liquefied and separated into nitrogen and oxygen in the air separation plant. The nitrogen is compressed and the bulk of it is used for blending into the purified synthesis gas. A slip stream of this nitrogen re-enters the air plant and is liquefied for use in the liquid nitrogen wash tower. Liquid oxygen is pumped thru a preheater to the Texaco generator.

Preheated natural gas also enters the generator, mixes with the oxygen and the highly exothermic reaction takes place. The products, mainly carbon monoxide and hydrogen, are quenched with water and enter the shift converted where in the presence of a catalyst, carbon monoxide reacts with steam to form additional hydrogen and carbon dioxide. The effluent from the shift converter passes through a heat exchanger, is cooled, flows through a liquid knockout drum and then to the carbon dioxide removal system.

Carbon dioxide is removed by absorption in a suitable medium such as monoethanolamine which is then reactivated by heat, releasing the carbon dioxide to battery limits. Any remaining carbon dioxide is removed from the hydrogen by scrubbing with sodium hydroxide.

The hydrogen stream then enters the liquid nitrogen wash tower where residual carbon monoxide, methane and argon are removed. The purified hydrogen is blended in specified proportions with nitrogen, produced at the air separation plant, and enters the Casale synthesis system.

The gaseous mixture of hydrogen and nitrogen is compressed to approximately 9000 psig and enters the reactor, via the jet ejector system which serves to return the unconverted recycle gases to the reactor. The ammonia synthesis is completed in the presence of a special catalyst.

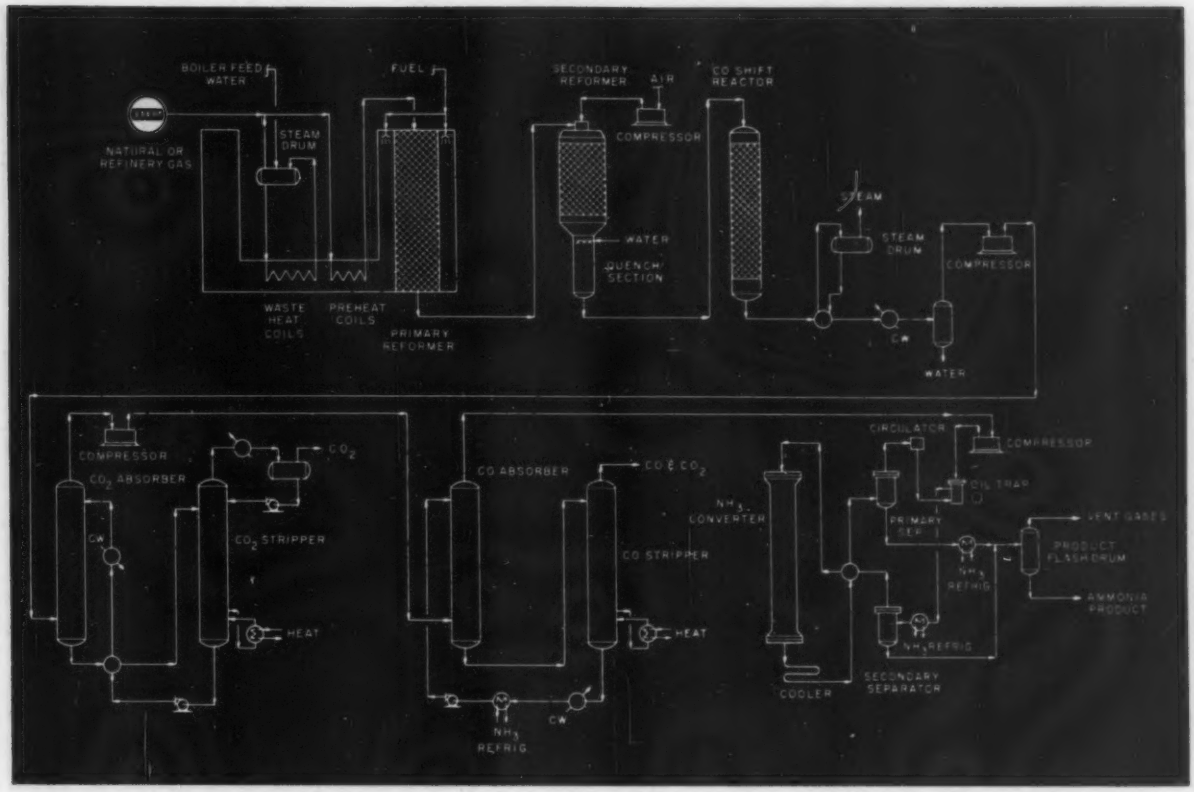
The effluent gases are cooled, the anhydrous ammonia is condensed in the final separating drum and the unconverted gases are returned to the reactor via the ejector system. The liquid anhydrous ammonia flows to storage.

The ejector system eliminates the necessity for a recirculating compressor for the unconverted gases.

Operating Conditions: Important operating conditions are mentioned in the above description.

Commercial Installations: Over 1500 tons per day of installed capacity.

References: PETROLEUM REFINER, Sept.'53,p178; CHEMICAL ENGINEERING, May'54,p332.



Ammonia—THE M. W. KELLOGG COMPANY

Application: A high pressure steam methane reforming process for ammonia production.

Charge: Natural Gas, Refinery Gas, Coke Oven Gas or Light Hydrocarbons and Air.

Product: High Purity Ammonia.

Description: The steam methane reforming process produces ammonia by steam reforming natural or refinery gas under pressure, followed by carbon monoxide shift, purification of raw synthesis gas and ammonia synthesis.

In the process, saturated and unsaturated hydrocarbons are decomposed by steam according to the basic equation:

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

It is normally advantageous with starting materials having a wide range of methane concentration (e.g., natural gas, refinery gases and coke oven gas, and other light hydrocarbons). Feed streams high in olefins or sulfur require pretreatment.

In the first step, the primary reformer converts about 70 percent of a natural gas feed into raw synthesis gas, in the presence of steam using a nickel catalyst.

Primary reformer effluent is then charged to a secondary reformer where air is introduced to supply the nitrogen required for ammonia. The heat of combustion of the partially reformed gas supplies the energy to reform the remainder of the gas after reacting with the oxygen in the air.

The high pressure reforming process utilizes the potential energy of the relatively high pressures at which natural gas normally is available. Although the synthesis gas must be still further compressed before charging to the ammonia converter, high pressure reforming conserves 30-40 percent in compressor horsepower over usual practices giving low pressure synthesis gases.

After leaving the secondary reformer, the mixture is quenched and sent to the shift converter. In the shift reaction, carbon monoxide in the gas streams is converted to carbon dioxide, and simultaneously makes hydrogen (a result of the reaction with steam).

Shift reactor effluent, after heat recovery, is cooled and compressed, then goes to the gas purification section. Carbon dioxide is removed from the synthesis gas in a regenerative MEA (monoethanolamine) system.

After carbon dioxide removal, carbon monoxide traces left in the gas stream are removed by scrubbing with a regenerative cuprous ammonium acetate solution.

The resulting pure synthesis gas passes to the oil separator, where it mixes with a recycle stream cooled with ammonia refrigeration, and goes to the secondary separator where anhydrous ammonia (contained in the recycle stream) drops out.

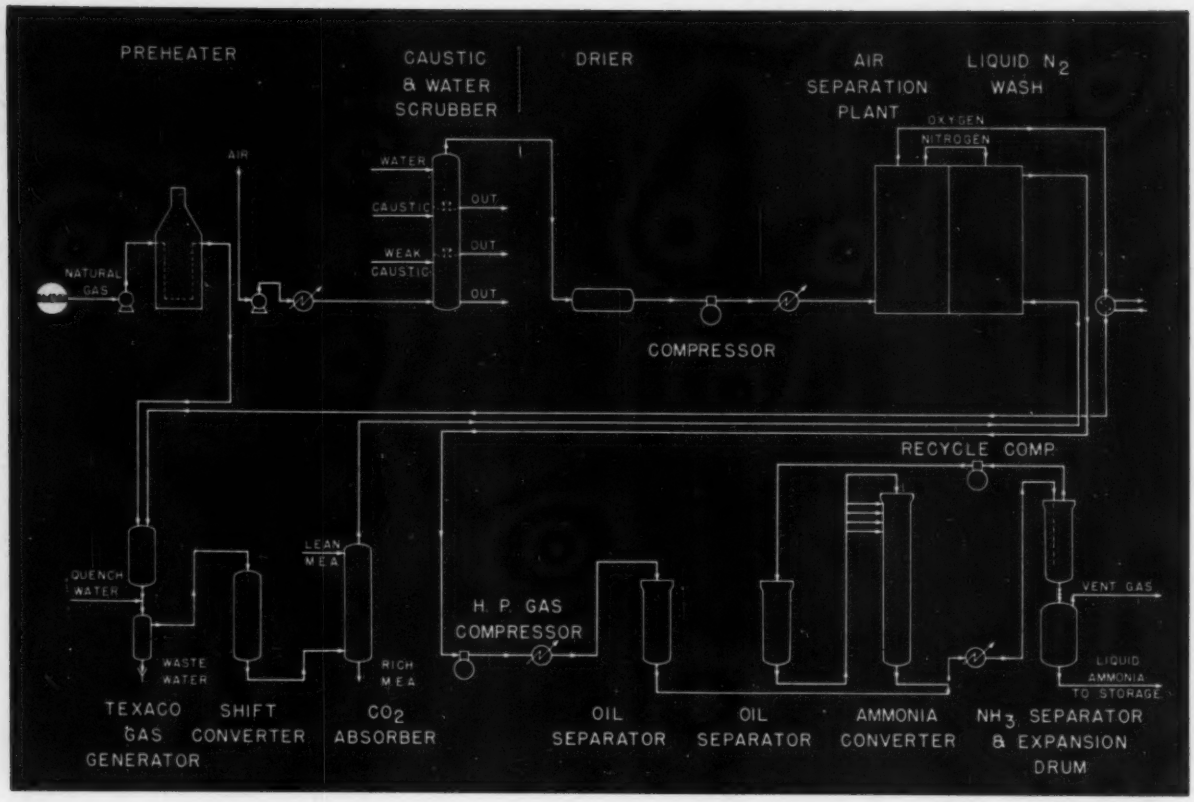
Synthesis gas is then passed through heat exchange and charged to the catalytic ammonia converter. Product gas from the converter is cooled and exchanged against converter feed gas.

Anhydrous liquid ammonia then separates out in the primary separator and, after further cooling, goes to the anhydrous ammonia product flash drum.

Operating Conditions—The feed to the reforming section is normally in the order of 200 psig. Temperatures in primary and secondary reformers are 1400-1800 F., while shift reaction temperatures are 700-850 F.

Ammonia synthesis is normally at 4700 psig. The "quench-type" ammonia converter was developed by Kellogg. Temperature is accurately and flexibly controlled inside the catalyst mass to allow a catalyst basket temperature gradient giving a maximum yield of ammonia per pass, regardless of production rate. Hot spots, common in catalyst baskets having tubular heat exchangers, and a cause of catalyst activity deterioration, are eliminated by the reactor's approach to isothermal conditions.

Commercial Installations: This process is in production at four plants with a fifth being brought on stream shortly. Total production is rated at over 1000 tons per day.



Ammonia (Uhde)—ARTHUR G. McKEE & COMPANY

Application: A process for manufacture of anhydrous ammonia.

Charge: Natural gas, ethane, LPG, any light hydrocarbon, residual oils, catalytic reformer tail gas.

Product: Liquid, anhydrous ammonia.

Description: Raw synthesis gas is produced by partial combustion of a hydrocarbon with oxygen in a Texaco gas generator. The oxygen is produced in a typical tonnage oxygen plant. This plant is modified to yield high-purity nitrogen.

Air is compressed to 100 psig, scrubbed in two stages with caustic solution to remove CO_2, with water to remove entrained caustic, and then is dried. It is then compressed to about 1000 psig and taken to the air separation plant. It is cooled, liquefied and distilled into three gaseous product streams: oxygen, impure nitrogen and pure nitrogen.

A portion of the pure nitrogen gas product is compressed to 315 psig, returned to the separation plant, and liquefied for use in the nitrogen wash plant.

The hydrocarbon feed stock is preheated to 800-850 F. in a fired heater. The oxygen is preheated to about 400 F. with steam. These two streams enter the Texaco gas generator at 325 psig where they react to form a raw synthesis gas. The reaction is quenched with water and cooled to about 400 F. The quench water scrubs out solid impurities from the gas.

The gas leaving the Texaco generator is chiefly H_2 and CO with small amounts of CO_2. Steam is used to convert the CO to CO_2 and H_2 by the water-gas shift reaction at 600 F. over a catalyst. Following this, the CO_2 is removed by treating with MEA solution and caustic, and the remaining gas is dried.

The dried gas is cooled by heat exchange to 300 F. and is then scrubbed with liquid nitrogen to remove the remaining impurities. The hydrogen remaining is extremely pure, containing 10 ppm or less of CO. It is necessary to add pure gaseous nitrogen to obtain the desired hydrogen-to-nitrogen ratio of 3:1.

The ammonia synthesis gas from the "cold box" is compressed to synthesis pressure of 6400 psig. The oil is carefully removed before the steam enters the reactor circuit. The entry point is immediately upstream of the ammonia condenser. As the ammonia condenses it dissolves the traces of impurities and removes them from the system.

The Uhde ammonia reactor has four beds of catalyst mounted in a high-pressure container. The main body of reacting gas enters at the top of the vessel and passes down along the shell through an annular space. This preheats the gas and keeps the pressure shell cool. The pressure shell can therefore be constructed of carbon steel. At the bottom the gas passes through the shell side of a shell-and-tube type exchanger built within the pressure shell cool. At the bottom the gas passes through the shell side of a shell-and-tube type exchanger built within the the convertor.

The reaction of H_2 and N_2 is strongly exothermic. To regulate the temperature over the catalyst some of the feed gas bypasses the preheater. It enters directly into the space between the catalyst beds cooling the gases leaving the catalyst bed above.

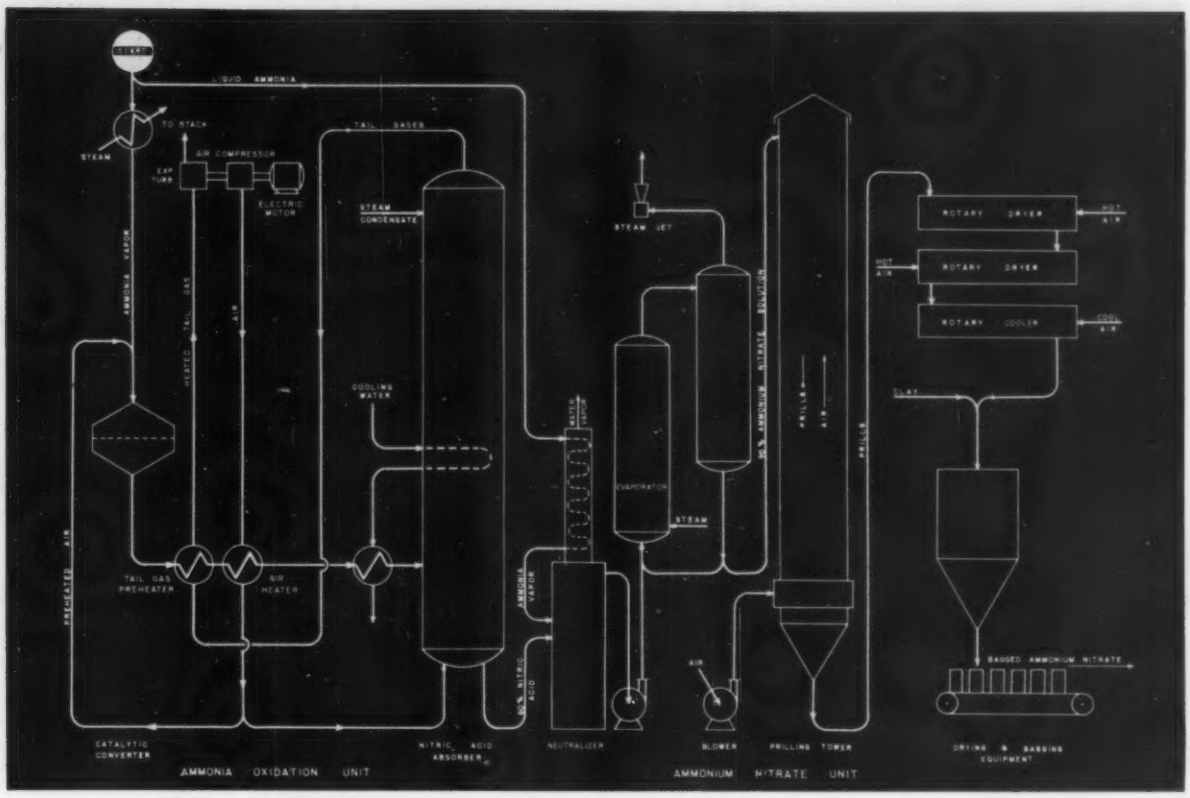
The gases leaving the bottom catalyst bed pass through the tube side of the internal heat exchanger before leaving the reactor. They are then cooled with water and pass to the ammonia separator where the condensed ammonia is withdrawn. The unreacted gases are returned to the reactor by the recycle compressor.

The condensed ammonia from the separator is depressured to the expansion drum. The gases evolved are vented to a fuel line. The liquid ammonia is taken to storage.

Other means of preparing the synthesis gas may be employed. When natural gas is available two-stage steam reforming under pressure followed by water gas shift conversion may be employed. In this case, there being no air separation plant, CO is removed by absorption in copper liquor.

Operating Conditions: The ammonia convertor operates at 6400 psig. Where conditions make it desirable this can be reduced to 4600 psig by use of mechanical refrigeration of the ammonia condenser. The internal temperature is maintained low enough that expensive materials of construction are not required. The catalyst is not expensive and is readily obtainable.

Commercial Installation: Uhde have installed over 40 ammonia synthesis plants in recent years. Among the latest are Farbwerke Hoeschst A. G., near Frankfurt, Germany and Typpi Oy at Oulu, Finland.



Ammonium Nitrate—THE GIRDLER COMPANY

Application: A process for manufacturing fertilizer grade ammonium nitrate.

Charge: Anhydrous liquid ammonia.

Product: Prilled ammonium nitrate with a nitrogen content of 33.5 weight percent.

Description: First, ammonia is oxidized with air to produce oxides of nitrogen which are then absorbed in water to form nitric acid. The reactions may be written as follows:

$$4\,NH_3 + 5\,O_2 = 4\,NO + 6\,H_2O$$
$$2\,NO + O_2 = 2\,NO_2$$
$$3\,NO_2 + H_2O = 2\,HNO_3 + NO$$

Ammonium nitrate is then formed by the reaction of nitric acid with ammonia as follows:

$$NH_3 + HNO_3 = NH_4NO_3$$

The DuPont process ammonia oxidation unit is shown. Anhydrous liquid ammonia is first vaporized and then mixed with clean, compressed air and passed over a platinum gauze catalyst at 100-psig pressure. This catalyst is contained in the converter and, as the reaction is highly exothermic, requires water cooling.

The hot gas emerging from the converter is cooled by heat exchange. The cooled gas then goes to an absorber tower where steam condensate is used for absorption. A secondary oxidation reaction occurs in the tower with the bleaching air which is introduced to the absorber. The nitric acid produced passes through the bleach tray where oxides of nitrogen are stripped from the acid.

In the production of ammonium nitrate, the ammonia, as a vapor, and nitric acid streams are metered and controlled individually to give as close neutralization as possible. Under normal operation a solution of 83 to 85 percent ammonium nitrate may be attained by allowing the heat of reaction to evaporate the excess water. The solution then goes to a storage tank.

Before solidification the solution is pumped to a vacuum evaporator where it is concentrated to about 95 percent ammonium nitrate. The prilling process of solidification is that of Canadian Patents and Development, Ltd. The 95 percent solution is pumped to the top of the prilling tower and sprayed countercurrent to an updraft of air. The free fall distance in the tower is greater than 100 feet. A wet granular salt is formed. Little or no moisture is lost in this process and the salt still has about 5 percent water.

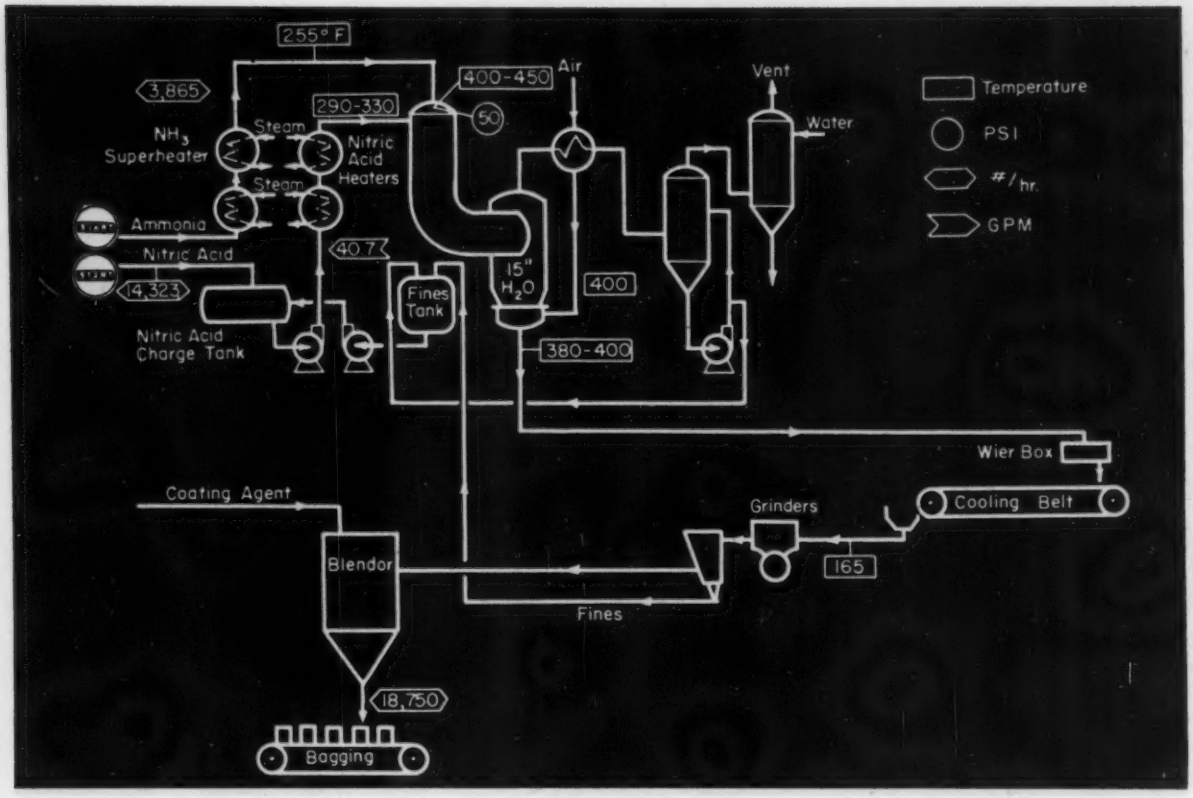
The wet salt is dried in rotary kiln-type dryers. The salt then passes through a cooler using unheated air. At this point the moisture content is about 0.1 percent. The ammonium nitrate is mixed with four weight percent clay to prevent caking during storage.

Yields: The over-all yield of ammonia to ammonium nitrate is about 95 percent. This amounts to about 2.25 tons fertilizer per ton ammonia feed.

Commercial Installations: Mississippi Chemical Company, Cooperative Farm Chemicals Association, Southern Nitrogen Co.

References: *Industrial and Engineering Chemistry*, Vol. 23,p860 (1931); Encyclopedia of Chem. Tech., Vol. 9, 333-5 (1952); Industrial & Engineering Chemistry, Vol. 45, No. 3,p496 March (1953).

The Girdler Company is a division of National Cylinder Gas Co.



Ammonium Nitrate (Stengel Process)—COMMERCIAL SOLVENTS CORP.

Application: A process for manufacturing fertilizer grade ammonium nitrate.

Charge: Anhydrous ammonia and nitric acid.

Product: Flaked ammonium nitrate.

Description: The Stengel process produces molten or dissolved ammonium nitrate of any desired concentration. No further concentration or evaporation is required for either prilling, graining of flaking. The process is not dangerous as there is no large amount of molten ammonium nitrate in the reactor at any one time and this is blanketed with steam until it enters the weir box.

Liquid anhydrous ammonia is vaporized and superheated to 225 F. and introduced along with nitric acid (containing ammonium nitrate fines, dissolved) at 290-330 F. into the top of the packed reactor. The reaction proceeds as follows:

$$NH_3 + HNO_3 \rightarrow NH_4NO_3 + 20{,}600 \text{ cal.}$$

This reaction product passes to a separator where heated air is introduced to reduce the water content and then molten ammonium nitrate is removed from the bottom. Before the air is introduced to the reactor it is heated to 400 F. by exchange with the separator overhead product and then introduced into the reactor in two different places. This air is blown up through the molten salt and carries with it water vapor. This process reduces the water content of the molten ammonium nitrate from about 2 percent to less than 0.2 percent. This air must be free from any oil or other carbonaceous matter since these materials make ammonium nitrate more susceptible to explosion.

The air leaving the stripper carries with it a small amount of entrained ammonium nitrate. To remove this, the air is scrubbed in a partial condenser to remove the ammonium nitrate and traces of ammonia. The concentrated liquor obtained from this scrubbing is recycled back to be used as solvent in the fines dissolving tank. The rate of recirculation of condensate in the partial condenser is controlled by the specific gravity of the concentrated liquor. The overhead from the partial condenser is scrubbed with water before venting to the atmosphere.

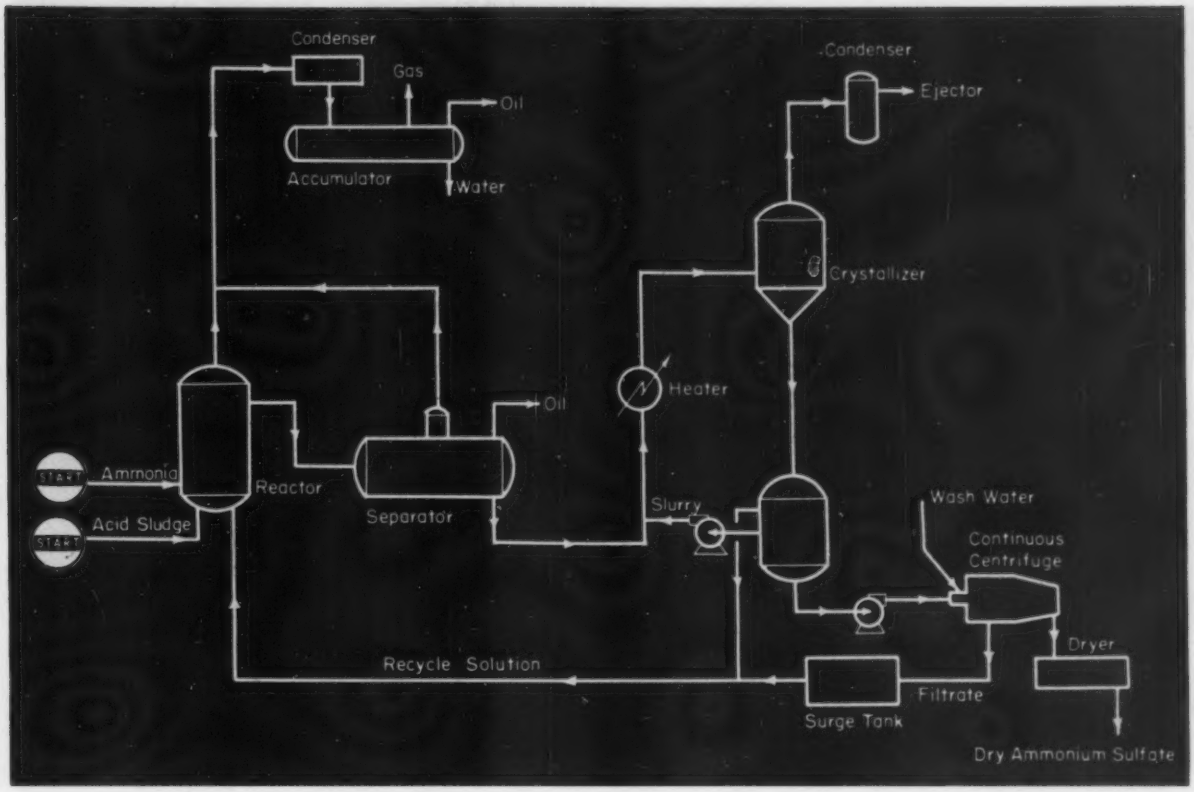
The molten ammonium nitrate product flows to a weir box and onto stainless steel cooling belts. The belts move over water and the molten ammonium nitrate solidifies. At the end of each belt the flake is broken up and goes to grinders and sizing equipment. The fines return to the nitric acid mixing tank.

The final product is coated with 3 pounds of diatomaceous earth for each 97 pounds of ammonium nitrate.

Yields: The over-all ammonia to ammonium nitrate is 100 percent.

Commercial Installations: Commercial Solvents Corporation, Sterlington, La.

References: Industrial and Engineering Chemistry, Vol. 46,Apr.'54,p622.



Ammonium Sulfate

Application: This is a process for the manufacture of dry ammonium sulfate.

Charge: Sulfuric acid-oil sludge and ammonia are the charge materials.

Products: The products are dry ammonium sulfate and recovered oil.

Description: The process described here represents an economical method for the reduction of atmospheric pollution through the use of refinery waste streams in the manufacture of ammonium sulfate. Except for the source of the charge, this process differs very little from one that would utilize fresh acid.

Sulfuric acid refinery sludge and either commercial ammonia or waste ammonia from various refinery streams are charged to the reactor where they form ammonium sulfate in an aqueous solution. The oil and carbonaceous material in the sludge do not interfere with the reaction. The charge acid strength may be as high as 30 to 50 weight percent, but the acidity of the reactor product is maintained at 0.5 percent. This final concentration promotes good crystal growth and assures complete utilization of the ammonia.

The reactor operates at a pressure of approximately 7 psig and a temperature of 240 to 245 F. Higher temperatures cause increased corrosion. The vigorous heat of reaction induces thermal mixing. Dilute ammonium sulfate solution is recycled to the reactor to absorb the heat of reaction. The product stream overflows to a separator for separation of the oil and aqueous phases. The gas and vapor from the reactor and separator pass to a condenser and accumulator for separation into the respective noncondensible gas, oil and water streams.

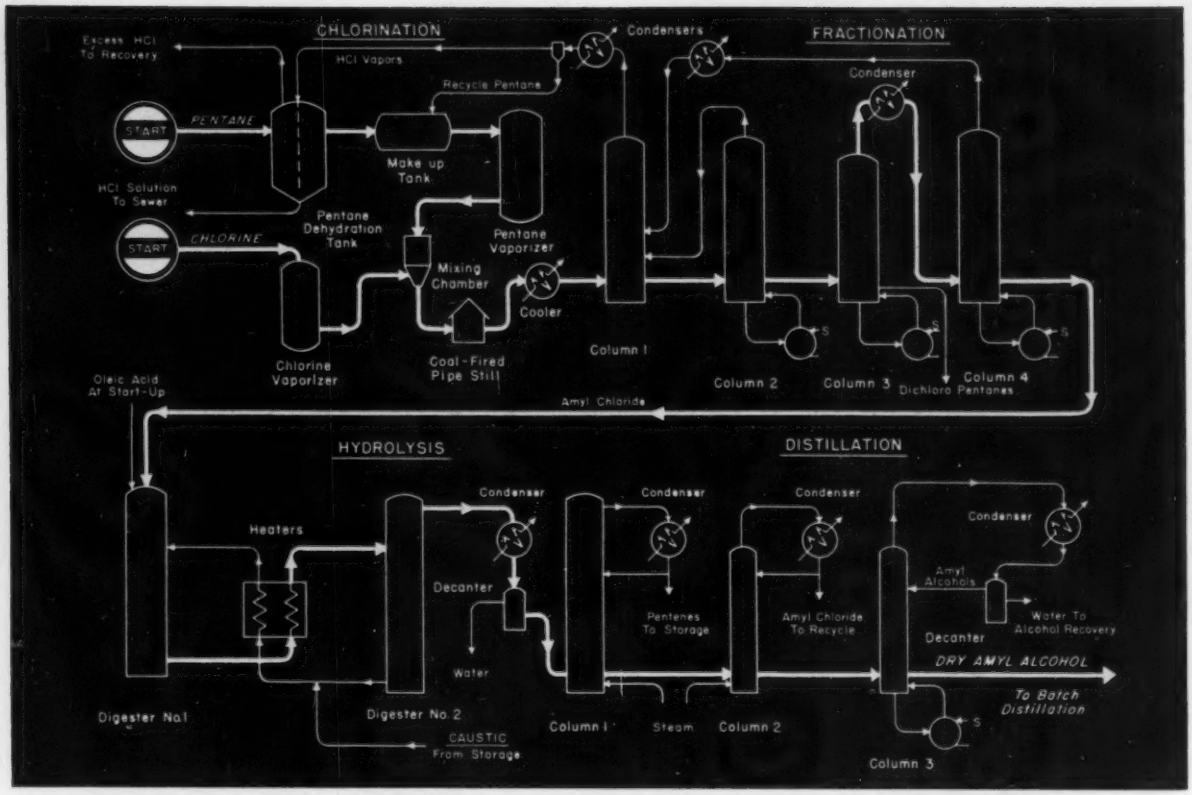
The solution from the separator is combined with a recycle ammonium sulfate slurry and charged to an evaporative crystallizer. Sufficient heat is added to maintain the crystallizer at the desired temperature. The solution is concentrated and the ammonium sulfate crystallized through evaporative cooling. A vacuum is maintained by an overhead condenser and jet ejector. Crystal growth is promoted by recycling slurry from the vessel below the barometric leg back to the crystallizer. Example conditions in the crystallizer are 150 F. with a pressure of 3 psia in the vapor space.

The slurry from the crystallizer is charged to a continuous centrifugal filter. The crystals are given a water wash by means of an internal wash line before they are discharged to the dryer. The filtrate liquor is recycled to the reactor. Saturated solution from the crystallizer may be added to the recycle filtrate for control purposes. The dryer reduces the water content of the crystalline ammonium sulfate to approximately 0.05 weight percent to prevent caking. The product is conveyed to storage bins through ducts by the use of dry air.

Operating Conditions: The principal operating conditions have been mentioned in the description above.

Yields: The yield of ammonium sulfate is approximately 95 weight percent, based on the acid in the sludge.

Commercial Installations: A variation of this process is employed by the General Petroleum Corporation at Torrence, Calif. Several other companies employ similar processes.



Amyl Alcohol— PENNSALT CHEMICALS CORPORATION

Application: Continuous process for the manufacture of amyl alcohols.

Charge: Pentane, chlorine, caustic soda.

Product: Various grades of mixed amyl alcohols, including primary, secondary, and tertiary isomers.

Description: Pentane is dehydrated by contacting with anhydrous hydrogen chloride, which is a by-product of the chlorination step. The anhydrous pentane and chlorine are vaporized separately, and then mixed in such proportions that the mixture is not in the explosive range. This mixture, at a temperature of about 120 C. then goes to a pipe still where the chlorination reaction takes place. The reactants leave the pipe still at about 300 C. and are immediately sent to a cooler to suppress the formation of dichloropentanes.

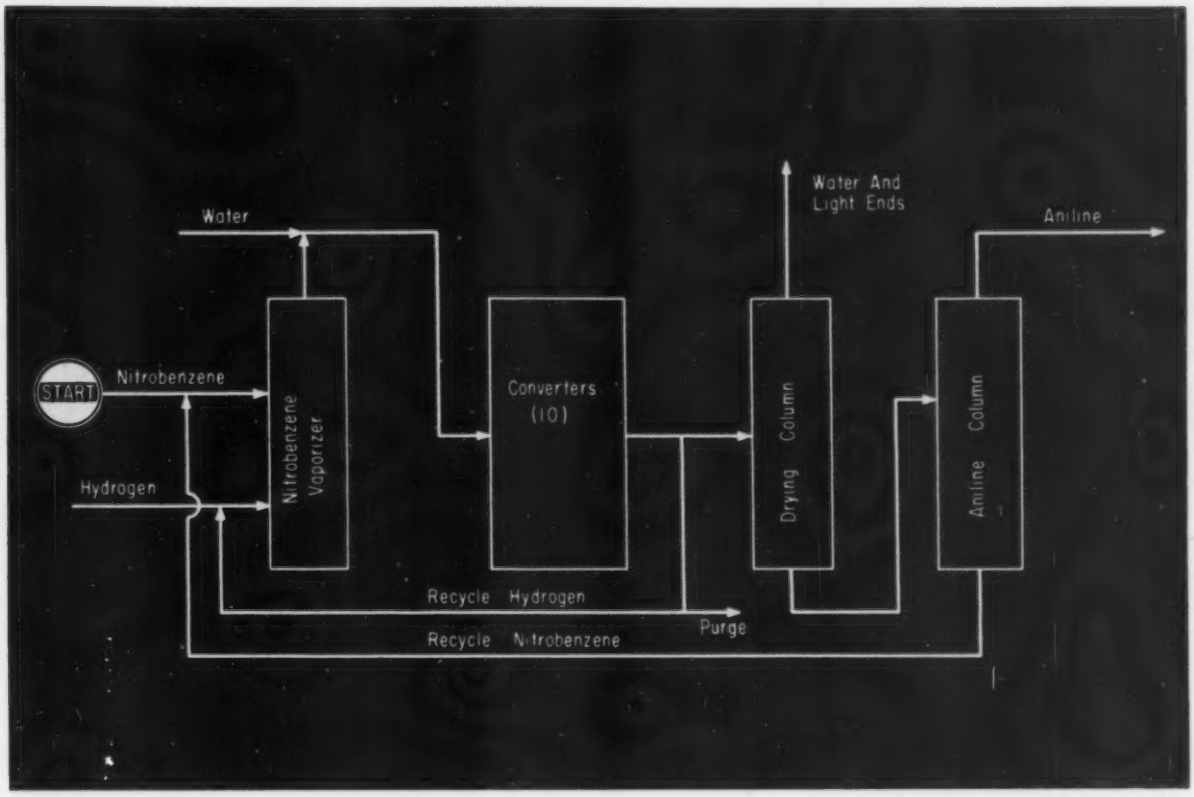
From the cooler the reaction mixture enters a fractionating column in which hydrogen chloride and pentane are removed overhead. The pentane is condensed and returned to the make-up tank. The hydrogen chloride is sent to the pentane dehydration tank where part of it reacts with the water in the pentane to form hydrochloric acid; the acid separates from the pentane and is periodically drained off to the sewer. The unreacted hydrogen chloride passes from the pentane dehydration tank to the recovery unit, where it is dissolved in water to form a commercial grade of hydrochloric acid.

The bottoms from the first column, consisting of amyl chloride, dichlorides, and some pentane, go to a second column, where the pentane is taken off overhead and recycled to the first column. The bottoms from the second column are sent to a third column where amyl chloride is taken off overhead, and dichloropentanes are removed as the bottom product. The amyl chloride then goes to a fourth column in which residual amounts of pentane are removed, and recycled to the first column.

The amyl chloride (a mixture of the primary, secondary, and tertiary isomers) is scrubbed with caustic to remove traces of hydrogen chloride, and is then fed to a digestor in which it is hydrolyzed to form amyl alcohol. Caustic soda is used as the hydrolyzing agent, and oleic acid as a catalyst. The mixture goes to a second digestor from which crude amyl alcohols are removed as a top product. Brine is formed as a by-product of the hydrolysis reaction, and is removed from the bottom of the second digestor.

The crude alcohol is condensed, and the water fraction removed by decantation. It then goes through a series of three columns in which amylenes (a by-product of the hydrolysis reaction), amyl chloride, and water are removed. The amylenes are used in the production of amylphenols in another process, and the amyl chloride is recycled to the digestors. Finally, the mixture of amyl alcohols is charged to a batch still where the various grades and isomers are separated by fractionation through a bubble cap column.

Reference: PETROLEUM REFINER, Sept.'53,p207. *Industrial & Engineering Chemistry,* Vol.42,2388 (1950).



Aniline From Nitrobenzene

Application: Vapor-phase reduction of nitrobenzene to aniline. The catalyst used is insensitive to sulfur poisoning and thus this process is especially suited for production of aniline from petroleum-derived benzene.

Product: Aniline.

Description: Mononitrobenzene, prepared from benzene by standard nitration processes, is fed to a lower tray of a bubble-tray tower. Heat supplied by the tower reboiler vaporizes the nitrobenzene into a stream of hydrogen which is fed up the tower. For the fixed-bed process, at least three times the theoretical amount of hydrogen required for the reduction is used, while for the fluid-bed process a much larger excess is required as a fluidizing medium.

The mixed stream of hydrogen and nitrobenzene is fed to (1) a series of fixed-bed catalyst chambers, or (2) a fluid-bed reactor. In the case of the fixed-bed system, water may be fed with the gas to absorb some of the heat of the reaction. A side-stream from the fluid reactor may be withdrawn through a cooling system and recycled to the reactor for control of the reaction temperature.

The effluent from the reactor system is cooled and the nitrobenzene and aniline condensed. The hydrogen is recycled except for a small purge stream needed to maintain the hydrogen at a purity of over 85 percent.

The liquid products are distilled to separate the water, and to separate the nitrobenzene for recycling. Crude aniline is redistilled for sale. Water must be removed by fractionation because aniline shows high (5 percent) solubility.

The catalyst in both processes is nickel sulfide supported on alumina. Careful control of the temperature of the reduction will give long active life for this catalyst (1600 hours). When the activity becomes low, the catalyst is regenerated by blowing with air at high temperatures followed by reactivation with hydrogen. No sulfiding step is needed.

The chemistry of the reaction is very simple:

$$C_6H_5NO_2 + 3H_2 = C_6H_5NH_2 + 2H_2O$$

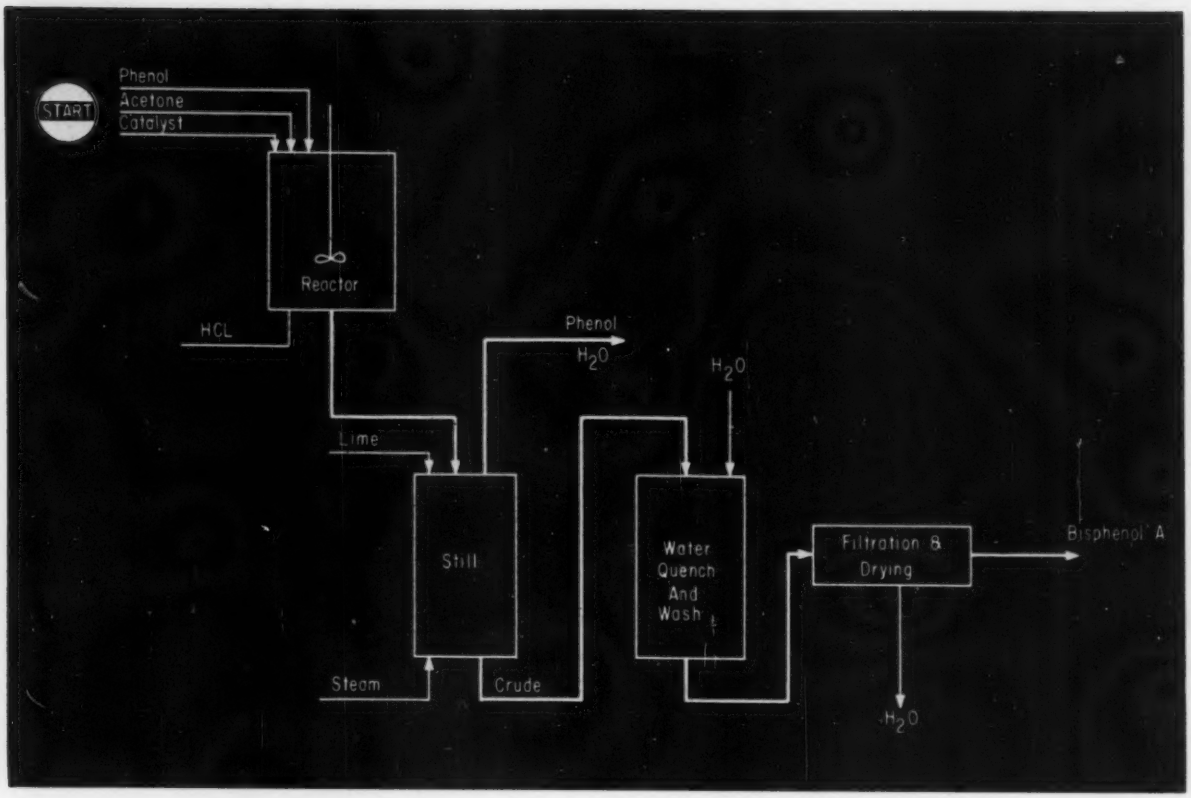
Operating Conditions: The reduction is carried out at near 300 C, and the temperature must be carefully controlled to avoid premature reduction of the catalyst activity.

Regeneration is accomplished at 300-700 C, with hydrogen reactivation of the catalyst at a somewhat lower temperature.

Yields: Reported yields are "almost quantitative."

Commercial Installation: American Cyanamid Company is building a plant at Willow Island, W. Va., which will use the fluid-bed process.

References: L. O. Winstrom (to Allied Chemical and Dye Corp.) U. S. 2,716,135 (Aug. 23, 1955); L. O. Winstrom and W. B. Harris (to Allied Chemical and Dye Corporation) U. S. 2,671,763 (Mar. 9, 1954).



Bisphenol A

Application: This is a process for the production of Bisphenol A (2,2 bis [4-hydroxyphenyl] propane).

Charge: Phenol, acetone, hydrochloric acid.

Product: Bisphenol A satisfactory for production of epoxy resins.

Description: Phenol and acetone in a molar ratio of 3:1 or 4:1 are charged to an acid-resistant stirred reactor. Glass-lined equipment is used ordinarily. A sulfur-containing catalyst is added, then dry hydrogen chloride gas is bubbled into the reaction mass. The temperature is maintained at 30-40 C for 8-12 hours. The product crystallizes from the reaction mixture to form a slurry.

At the end of the reaction, the mixture is washed with water and just enough lime is added to neutralize the free acid. Vacuum and heat are applied to the reaction kettle and water and phenol distilled separately from the mixture. The batch is finished by blowing the molten product with steam under vacuum at 150 C to remove the odor of the sulfur-containing catalyst.

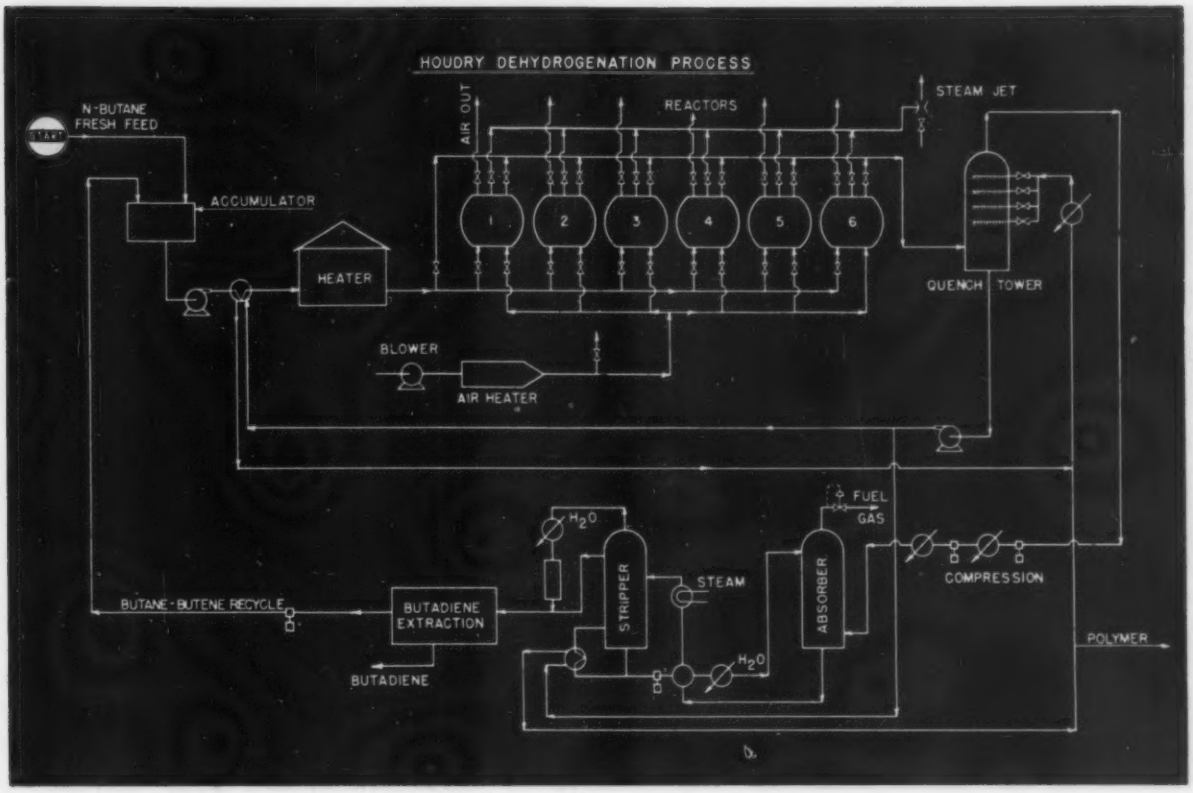
The molten product is quenched in a large volume of water, filtered, and dried. It is a light tan powder, which may be further purified by recrystallization from solvents.

Operating Conditions: The main reaction is run near room temperature, 30-40 C, depending on the catalyst used. Water is removed from the product at about 60 C. and the final distillation of unreacted phenol and the steam deodorization are carried out near 150 C. The catalysts used my be any ionizable organic sulfur compound, including mercaptocarboxylic acids, mercaptans, and hydrogen sulfide.

Yields: Yields of 98 percent based on acetone are reported.

Commercial Installations: This process or similar ones are used by Dow Chemical Company, Midland, Mich.; Monsanto Chemical Co., St. Louis, Mo.; and Shell Chemical Co., Houston.

References: R. P. Perkins (to Dow) U. S. 2,191,831 (Feb 27, 1940); R. P. Perkins and Fred Bryner (to Dow) U. S. 2,359,242 (Sept. 26, 1944); W. L. Stoesser and E. Sommerfield (to Dow) U. S. 2,623,908 (Dec. 30, 1952)



Butadiene from Butane—HOUDRY PROCESS COMPANY

Application: An adiabatic fixed-bed catalytic process for dehydrogenation of n-butane to butadiene and/or butenes.

Charge: Fresh feed of butane, together with the butane-butene mixture recycled from the final butadiene purification section.

Product: A crude butadiene stream from which high purity butadiene can be extracted.

Description: The charge is pumped from an accumulator through a feed-quench oil heat exchanger and a heater, being heated to approximately 1150 F. before entering the reactor.

Effluent from the reactor is quenched by direct contact with circulating quench oil, and moves from the quench tower to a knockout drum and then to the first of four compressor stages. Overhead from the last knockout drum passes to a conventional absorber and then to a stripper for recovery of C_4 and heavier material. Bottoms from the knockout drum also move to the stripper. Effluent from the stripper goes to the butadiene recovery and purification plant, and butane-butene recycle stock is then fed to the charge accumulator in a continuous operation.

On-stream time of each catalytic reactor in the series may be from 7 to 15 minutes, but generally is in the 8-10 minute range. Each on-stream period is followed by vacuum purge to remove hydrocarbons, after which regeneration is carried out with air that is pre-heated by direct combustion of fuel in the air stream.

In a three-reactor series, one chamber receives hydrocarbon feed while the second receives regeneration air and the third undergoes valve changes and purging.

Catalyst: The catalyst employed is in the form of cylindrical pellets consisting of active alumina impregnated with 18-20 percent chromic oxide. It is necessary to prevent contamination of the catalyst with iron. Small amounts of iron oxide are catalytically active at process conditions, resulting in large amounts of coke and light gas, plus spalling and catalyst breakage.

Operating Conditions: Major process conditions in butadiene production are as follows:

Average temperature	1125 F.
Pressure	5 in. Hg. Abs.
Space rate	1-3 vol. chg./vol. cat./hr.
On-stream period	7-15 min.

Yields: Typical yields of butadiene and butenes in dual-purpose commercial operation are shown in the table below:

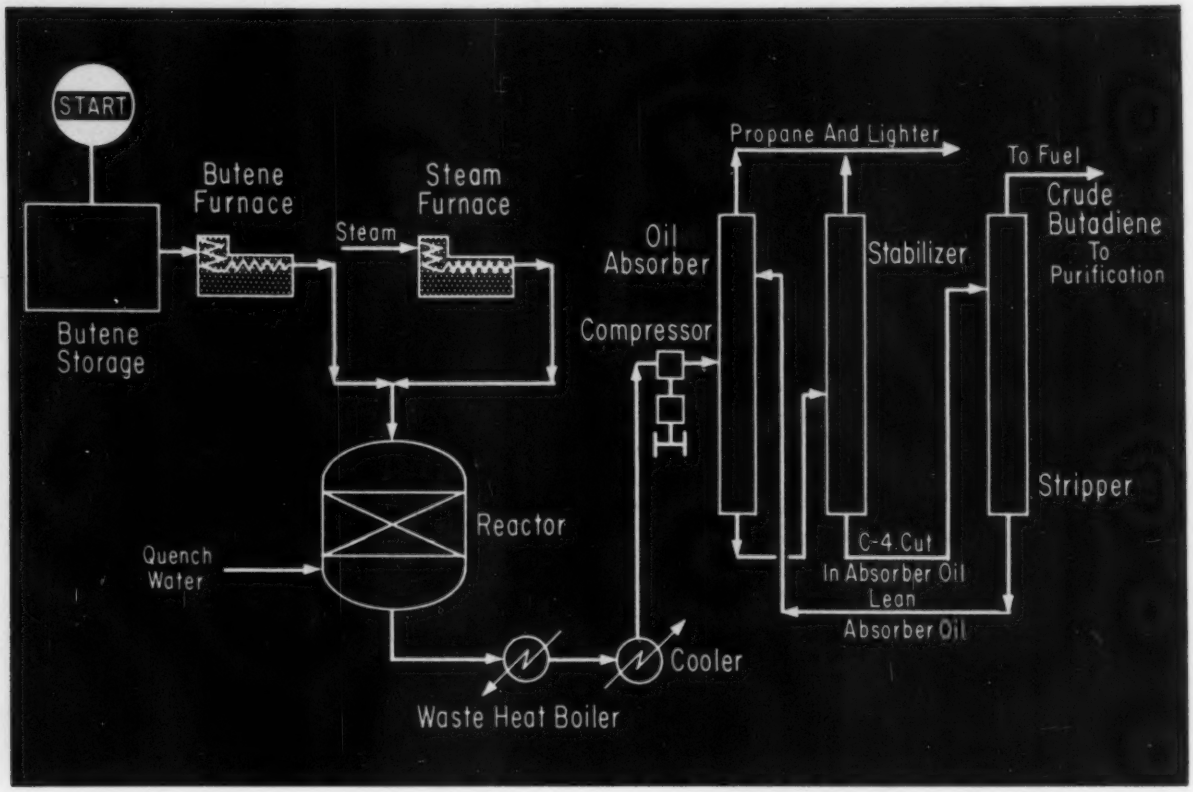
	Total Reactor Feed Wt. %	Total Reactor Product Wt. %	Calculated Ultimate Yield Wt. % Butane Feed
Hydrogen		1.5	4.5
Methane		2.5	7.4
Ethane-Ethylene		2.3	6.9
Propylene		2.2	6.5
Propane		.4	1.2
Isobutane	2.0	1.4	
Isobutene, Butene-1	1.5[2]	9.7	24.4
Butadiene	.4	8.4	23.8
n-Butane	83.9	50.9	
Butene-2	12.2	19.2	20.8
C_{5+}		.3	0.9
Coke		1.2	3.6
Total	100.0	100.0	100.0

[1] Yields shown are average of daily yields for one week, taken after several months of plant operation.

[2] In this operation butene-1 and isobutene are selectively removed as product. When maximum butadiene is desired, all butenes are recycled to the process.

Commercial Installations: Eight units are in operation or under construction, with total nominal design capacity of 308,000 annual short tons of butadiene, or equivalent.

Reference: PETROLEUM REFINER, Dec.'54,p173.



Butadiene from Butenes— ESSO RESEARCH AND ENGINEERING COMPANY

Application: A process for the catalytic dehydrogenation of normal butenes to butadiene-1,3.

Charge: A C_4 hydrocarbon stream containing about 80 weight percent n-butenes.

Product: A crude butadiene stream from which high-purity butadiene can be extracted.

Description: The feed is preheated to about 1000 F. in the hydrocarbon superheater. The hot gases are then mixed with superheated steam and the mixture is passed through the fixed-bed catalyst.

The low partial pressures necessary for the dehydrogenation of the butenes to butadiene by the catalyst are obtained by the use of this steam. Carbon deposited on the catalyst is removed by a "water gas reaction" with steam, partially during the dehydrogenation and partially during the regeneration cycle.

The hot gases leaving the reactor go through steam generators where they are cooled and where some of the steam for the process is generated. The hot reactor effluent is further cooled in an oil quench tower and a water quench tower. Water condensed from the effluent after compression is stripped of any volatile hydrocarbon in a water stripping tower and is then discharged to a blowdown system.

After compression and cooling, the effluent enters a condensate separator. The gases from the separator are fed to the absorber where the C_4 hydrocarbons are absorbed in a light naphtha which is then recycled to the oil quench tower. The condensate from the separator, containing the unstabilized C_4 cut, is fed to the stabilizer where the lighter components are removed overhead.

The bottoms stream from the stabilizer is fed to the rerun tower where the C_5 and heavier components are removed as bottoms. The overhead stream is the crude butadiene product.

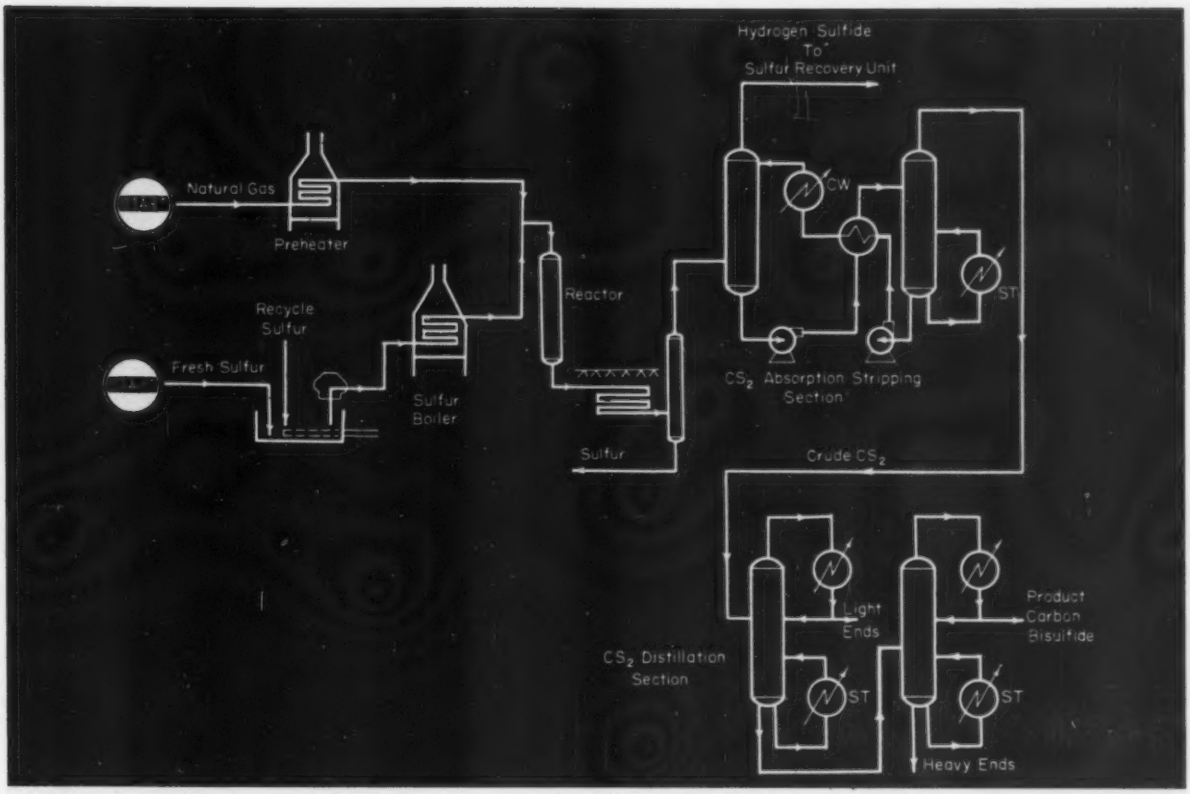
Operating Conditions: The principal operating conditions are:

Space velocity, V/H/V (Volume of n-butene as gas at standard conditions per hour per volume of catalyst)	125-225
Pressure Above Bed, psig	7-11
Pressure Below Bed, psig	2-4
Partial pressure, mm Hg. (at reactor inlet)	60-80
Steam/Butene, Gas Volume Ratio	14-18
Temperature, F.	1150-1250

Yields: Typical once-through yields* are as follows:

	Feed Weight Percent	Products Weight Percent
Normal Butenes	80.0	60.0
Butadiene	2.0	16.4
Other C4's	18.0	16.0
Polymer	....	1.0
Fuel Gas and Coke	....	6.6

* Yields and operating conditions will depend upon the catalyst used.



Carbon Bisulfide

Application: A process for the manufacture of carbon bisulfide.

Charge: Natural gas, predominantly methane and containing a minimum of propanes-plus; sulfur, 99 + percent purity.

Product: Rayon-grade carbon bisulfide 99+ percent purity.

Description: Fresh sulfur is melted, if necessary, and combined with recycle sulfur in an underground tank. The sulfur is maintained in the molten state at 250-270 F. by steam coils, and is transferred continuously to the boiler by means of a well-type pump. The boiler produces a superheated vapor at 1100-1200 F. and 20-30 psig, under which conditions most of the sulfur is in the diatomic form. The boiler is of stainless steel construction and presents maintenance difficulties due to the corrosiveness of sulfur and to the fouling tendencies of impurities in the sulfur. Pebble heaters have been proposed as a partial solution to this problem.

Methane (natural gas) is preheated separately to 1000-1200 F., depending on the heavy impurities and their tendency to decompose. The preheated sulfur and methane streams are then mixed and passed down through the reactor where carbon bisulfide is formed according to the formula:

$$CH_4 + 2\,S_2 = CS_2 + H_2S$$

The reactor is a vertical, stainless steel vessel filled with silica gel catalyst (a number of other materials may be used as catalyt) and operated adiabatically. Typical reaction conditions are: temperature, 1050-1150 F.; pressure, 20-30 psig; vapor hourly space velocity, 400-600. Approximately stoichiometric proportions of sulfur and methane are used, and they are about 95 percent converted during passage through the reactor.

The reaction yields approach theory very closely. By-products include light mercaptans and heavy di- and poly-sulfides. The reactor effluent is cooled in a sprayed U-bend exchanger and passed to a tank from which condensed sulfur is withdrawn at 250 F. This sulfur could be recycled, but is small in quantity and in addition contains accumulated tars.

Sulfur is de-entrained from the exit gases, and they are then fed to an absorption column in which carbon bisulfide is removed by a selective, mineral oil-type solvent. The rich oil is pumped to a stripper where the carbon bisulfide is removed and sent to the distillation section. The off gas from the absorber contains 90-95 percent hydrogen sulfide and passes to a sulfur recovery unit. Details of this unit are given elsewhere in this handbook.

The stripped carbon bisulfide is purified in two successive distillations, with the final product being taken overhead from the second column. The distillation columns are of steel construction and utilize refrigerated overhead condensers.

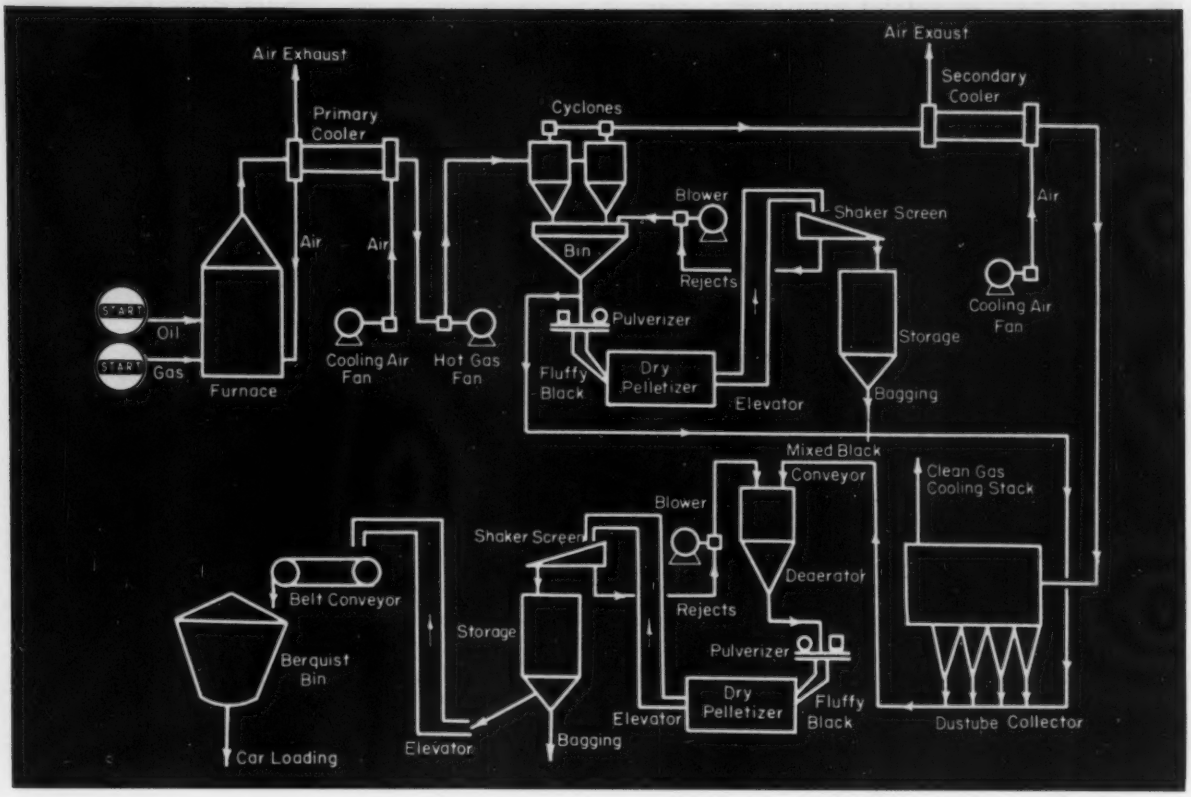
The carbon bisulfide product is stored and shipped in steel containers. A blanket of water is used to minimize fire hazards. Further purification of the product is required before it can meet USP requirements.

Operating Conditions: Typical conditions for the catalytic reaction between methane and sulfur are given in the above text.

Yields: Typical over-all process yields:
Carbon bisulfide from methane — 90-95 percent
Carbon bisulfide from sulfur — 85-90 percent

Commercial Installations: This process or a variation is used by Barium Reduction Corp., South Charleston, W. Va.; Food Machinery and Chemical Corp. (Westvaco Chlor-Alkali Division), South Charleston, W. Va.; Stauffer Chemical Co., Mobile, Alabama.

Reference: For a discussion of the reaction conditions, see the paper by H. Folkins, E. Miller, and H. Hennig, *Ind. Eng. Chem.*, **42**, 2202 (1950).



Carbon Black (Lynn Process)—LYNN CARBON BLACK COMPANY, INC.

Application: A process for the manufacture of furnace type carbon black.

Charge: Natural gas or a combination of natural gas and petroleum oil.

Description: The furnace types of carbon blacks are normally made by the high temperature cracking of natural gas and/or petroleum oil and are known as gas blacks or oil blacks, depending upon the primary feed stock. Carbon blacks are further separated into color or rubber blacks with varying properties which must be closely controlled to the specifications and grades required for their intended commercial use.

The simplified flowsheet is typical for a plant producing a gas black or gas and oil blacks. In the manufacture of gas blacks natural gas is introduced into the interior of a multi-port burner at a very low pressure, preheated air is simultaneously introduced around the flame of the gas burner, but at a low point in the interior of the furnace. Temperatures in this zone range from 2200-2400 F. The combustion process temperatures are in the main controlled by the air-gas ratio which may vary from 4:1 to 8:1 depending on the type and quality of carbon black to be made.

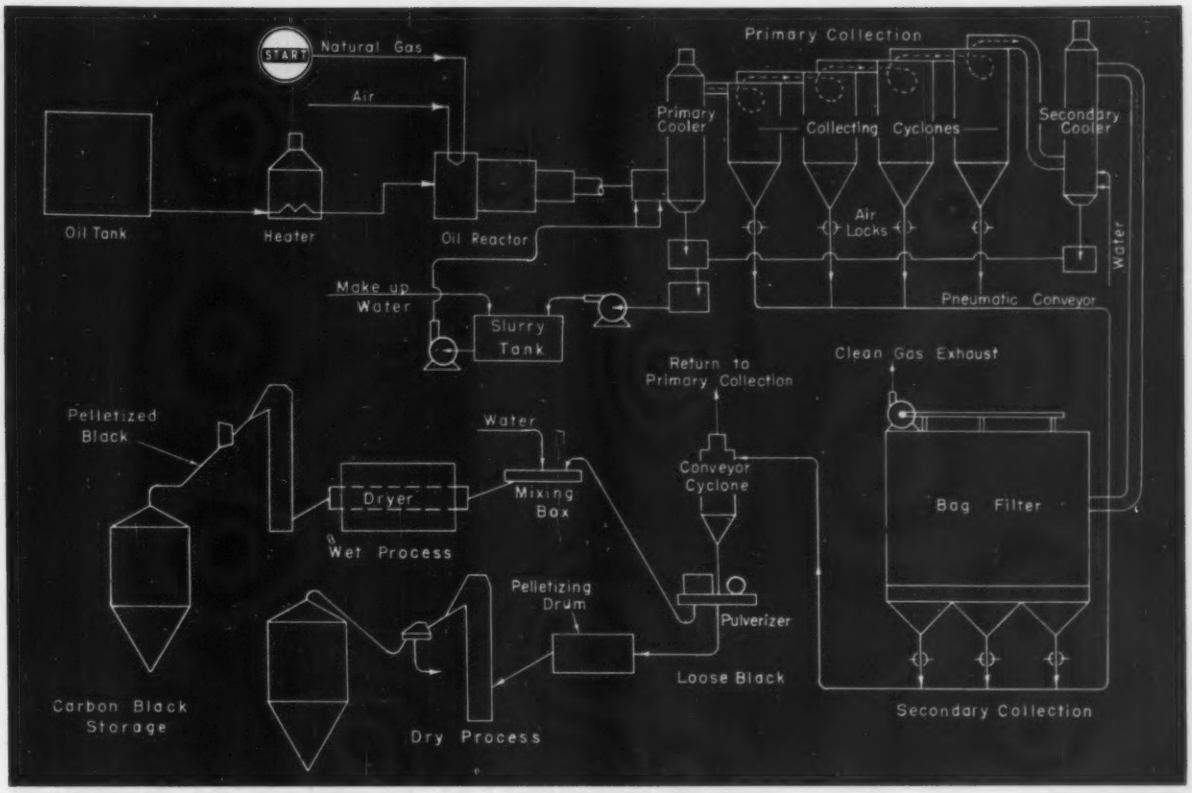
Above the gas burners at higher temperatures, dissociation occurs. It is within this zone that oil, when used, is introduced by means of vertically located air-cooled oil burners with mechanical atomization and varying air ratios. Within the furnace a highly turbulent region exists and temperatures may vary from 2600-3000 F., the feed-stock is cracked to its components of carbon and hydrogen. The conditions that obtain in this zone may be described as a heterogeneous gas phase catalytic reaction. Products of combustion and carbon black produced, then leave the furnace and enter the primary cooler.

In the primary cooler the carbon black gas mixture is cooled to about 1000 F. with a counter-current flow of air. A possible additional reversible reaction occurs during this stage which may add to the yield of carbon black. From the primary cooler the products enter cyclone collectors where between 60 to 80 percent of the black is collected, atmospherically cooled and stored for bagging or pelletizing, or sent on for mixing for final products.

From the cyclones the balance of the carbon black and products of combustion enter the secondary cooler where they are cooled to about 275 F. and then enter a Dustube collector where the balance of the black is collected. Carbon black from the secondary collector may be mixed with the primary product or sent on to the deaerator for compaction as a loose of fluffy black. Both the primary and secondary recovered blacks must be pulverized and are therefore sent through a high speed hammermill before either bagging as a loose black or to be pelletized. Pelletizing is accomplished by means of a dry process wherein the carbon black is fed into a slowly rotating drum which forms small pellets. The pellets are then elevated to a shaker screen where they are separated and screened to the required size, rejects are returned to the hammermill. Pelletizing increases the bulk density which, in the typical rubber blacks vary from 21-24 pounds per cubic foot, it also results in a relatively clean and free flowing product, much preferred by the user.

Yields: The yields are dependent upon the carbon content of the feed stock. Recoveries from an average natural gas are about 12-14 pounds per 1000 cubic feet for the Semi-Reinforcing Furnace type of blacks.

References: *Chemical and Engineering News,* Vol.32,No.33,Aug. 16,'54,p3294; *Chemical Week,* Aug.14,'54,p40; *Chemical Engineering,* July'53,p120; *The Oil and Gas Journal,* May9,'55,p120.



Carbon Black (Oil Black)

Application: A process for manufacturing highly-reinforcing furnace blacks from heavy residual oils.

Charge: Heavy residual oil, natural gas, air.

Products: HAF and SAF carbon blacks, pelletized, bulk density 23 pounds per cubic foot minimum.

Description: Oil is preheated in a direct-fired or molten-salt type heater and introduced into a reactor in which gas and air are burned to provide the heat necessary to crack the oil. The furnace used is the Phillips type reactor (Krezci, J. C., to Phillips Petroleum Company, U. S. 2,564,700, August 21, 1951) under a licensing agreement. Air for the reactor is furnished by centrifugal blowers. The temperature in the oil reactor is maintained at about 2500 F by controlling the air pressure at about 4 psig. The oil is cracked to carbon and hydrogen with side reactions producing carbon dioxide, carbon monoxide, and water. Trace amounts of acetylene and methane are also produced.

In the quench section of the reactor, direct water sprays cool the carbon black-gas mixture to about 1200 F. The mixture is air-cooled in a long duct, partially finned to take advantage of some air cooling, to about 700 F. in a long ceramic tube, then enters a vertical cooling tower, sized for a velocity of about 25 feet per second, in which water sprays reduce the temperature to about 550 F.

The cooled reaction mixture passes into a series of four cyclones which remove about 70 percent of the black, then into a secondary cooler in which more water sprays cool to under 300 F. Final cleaning of the gas occurs in a bag filter in which Orlon bags remove essentially 100 percent of the black. Alternatively, a wet scrub may be used for final recovery, with the resultant slurry used for quench water in the furnaces.

Carbon black is continually discharged from the collection equipment by rotary valves and picked up by a pneumatic conveyor. The black is collected in a smaller diameter collecting cyclone and disharged through a high speed hammer mill to break up and disperse the very small quantities of hard agglomerates that may be present.

Carbon black is pneumatically conveyed to the pelletizing systems, after passing through a high-speed hammer mill to eliminate hard aggregates. Either wet or dry pelletizing is used, depending on the bulk density required and the method of shipment preferred.

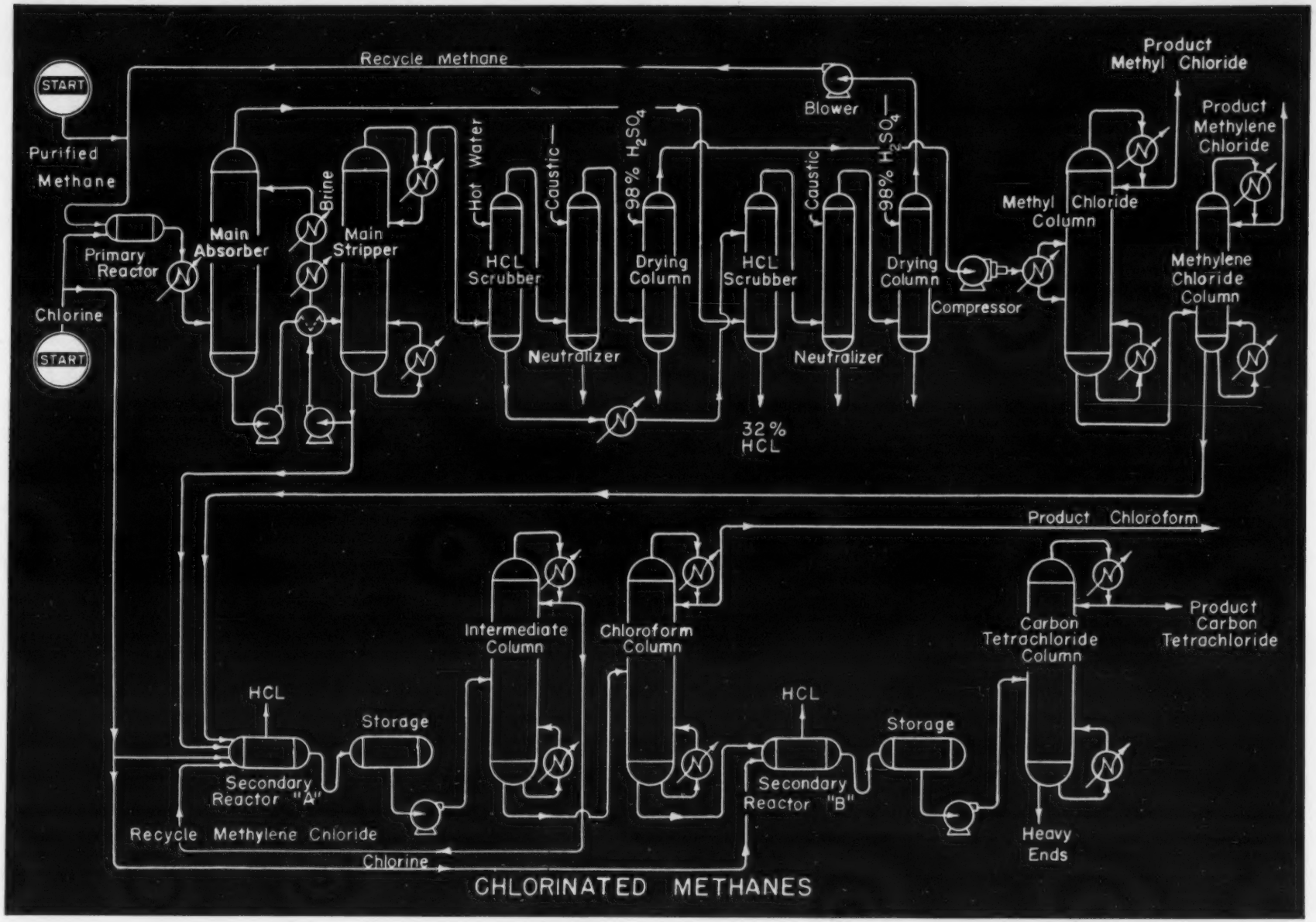
Pelletized black is shipped in bulk hopper cars or in 50-pound three-ply kraft paper bags.

Operating Conditions: The critical operating conditions are those in the reactor design. Reactor design and control determine yields and quality.

Yields: The process yields up to 60 percent of the actual carbon content of the oil feed as finished black.

Commercial Installations: This process or variations is in use by Continental Carbon Company at Ponca City, Okla., and Westlake, La.; and by Cabot Carbon of Canada, Ltd., at Sarnia, Ont.

Reference: Petroleum Refiner, Dec.54,pp179-181.


Recycle Methane
START
Purified Methane
Primary Reactor
Chlorine
START
Main Absorber
Brine
Main Stripper
Hot Water
HCL Scrubber
Caustic
Neutralizer
98% H_2SO_4
Drying Column
Blower
HCL Scrubber
Caustic
Neutralizer
98% H_2SO_4
Drying Column
Compressor
32% HCL
Product Methyl Chloride
Methyl Chloride Column
Product Methylene Chloride
Methylene Chloride Column
Product Chloroform
Intermediate Column
Chloroform Column
Carbon Tetrachloride Column
Product Carbon Tetrachloride
HCL
Storage
Secondary Reactor "A"
Recycle Methylene Chloride
Chlorine
HCL
Storage
Secondary Reactor "B"
Heavy Ends
CHLORINATED METHANES

Chlorinated Methanes

Application: This is a process for the manufacture of chlorinated methanes.

Charge: Methane and chlorine, both of 99 percent purity, are the charge materials.

Products: Methyl chloride (CH_3Cl), 99 percent purity, methylene chloride (CH_2Cl_2), 88-92 percent purity; chloroform ($CHCl_3$), 99 percent purity; and carbon tetrachloride ($CHCl_4$), 99 + percent purity, are the products.

Description: Chlorination of methane may be effected either thermally or photochemically. In the representative process described here, thermal activation is used for the primary chlorination and photochemical activation for the following secondary chlorinations. Such a process is designed for maximum flexibility regarding production rates of the four chlorinated methanes.

The primary chlorination step involves the reaction between methane and chlorine in a multitubular reactor. The reactants are preheated (by direct or indirect heat exchange with reaction products), mixed at high velocity, and allowed to react at temperatures in the range of 650-750 F. The methane to chlorine ratio must be controlled carefully, since slight variations can alter the product distribution considerably. In addition, care must be exercised to prevent ignition and consequent degradation of products to carbon and hydrogen chloride. Thus, high tube velocities and effective heat removal are design features of the reactor.

In a typical case, chlorine and methane (including recycle) are fed to the primary reactor in a molar ratio of 0.6 to 1.0. Operating pressure is slightly above atmospheric. Chlorine conversion is essentially complete, and methane conversion is on the order of 65 percent. The effluent gases include unreacted methane, traces of chlorine, hydrogen chloride, heavy chlorinated compounds, and chlorinated methanes in the following approximate molar ratio:

Methyl chloride	6.0
Methylene chloride	3.0
Chloroform	1.0
Carbon tetrachloride	0.25

The products are cooled and sent to the main absorber where chlorinated materials are separated from methane and hydrogen chloride. The latter materials comprise 75-80 percent of the reactor effluent. The solvent for the absorber is a chilled mixture of chloroform and carbon tetrachloride. The lean gas from the absorber, containing less than 3 percent chlorinated hydrocarbons, passes to a water-cooled graphit tower where it is scrubbed with dilute (less than 15 percent) hydrochloric acid. The bottom product from this tower is 32 wt-percent acid. The off gas is then further scrubbed with caustic soda solution and finally dried with concentrated sulfuric acid. The resulting dry methane is recycled to the primary reactor by means of a blower.

The bottoms product from the main absorber is preheated and fed to the main stripper wherein residual chlorine and hydrogen chloride, plus significant amounts of the lighter chlorinated methanes are removed overhead. The off gas passes to a rubber- and brick-lined tower wherein hydrogen chloride is removed by scrubbing with 130 F. water. The tower is operated at elevated temperatures to avoid condensation of the chlorinated methanes. The overhead gas, containing 0.3-0.5 percent hydrogen chloride, is neutralized and dried by successive scrubbing with dilute caustic solution and concentrated sulfuric acid.

The dry gas is compressed to about 110 psig and fed to the methyl chloride column. The overhead product from the distillation in this column contains product methyl chloride of 99 percent purity, which meets technical grade specifications. The bottoms product is fed to the methylene chloride column where 88-92 percent methylene chloride is removed overhead. Only a portion of the methylene chloride is thus removed, the remainder being left in the bottoms product for further chlorination. Thus, the bottoms from the methylene chloride column are combined with the bottoms from the main stripper and are charged to secondary reactor "A".

The secondary chlorinations are carried out in the liquid phase, using photochemical activation. Special reactors expose a maximum of liquid at close range to mercury-arc lamps. Fresh chlorine is introduced to convert methylene chloride to chloroform. The reactor operates at essentially ambient temperature, with the exothermic heat of reaction being removed by cooling coils and a reflux condenser. Hydrogen chloride escapes and is collected in scrubbing equipment similar to that described earlier in the process.

The overflow from the reactor is fed to the intermediate column, where unreacted methylene chloride is removed overhead and recycled to the reactor. The bottoms product from the intermediate column passes to a fractionator wherein USP chloroform (99.0-99.5 percent purity) is removed overhead. The botttoms stream from this second tower contains chloroform and lesser amounts of carbon tetrachloride and high boilers. This mixture is combined with fresh chlorine to form the charge for secondary reactor "B".

In this second photochemical reactor chloroform is converted to carbon tetrachloride. Design and operation of the reactor are similar to the "A" reactor. The effluent passes to a fractionator wherein 99.5 percent carbon tetrachloride is removed overhead. The bottoms product from this fractionator contains residual higher chlorinated materials formed during the three reaction steps.

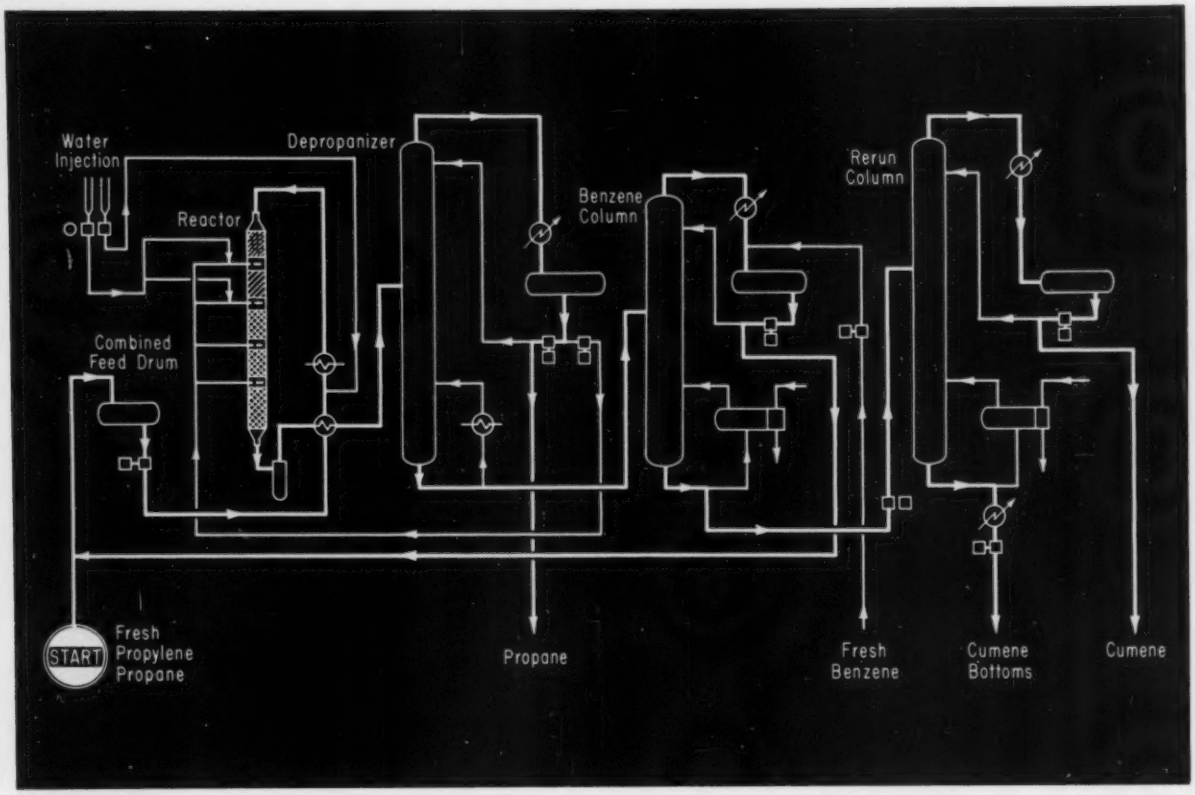
A portion of the above-described process can be used if a high degree of production flexibility is not required. For example, a single thermal reactor employing moderate recycle of methyl chloride may be used. The product from the reactor is scrubbed, neutralized, and compressed. Separation of the four chlorinated methanes is then carried out by conventional straight fractionation. The ratio of methane (and recycle methyl chloride) to chlorine in the reactor feed may be as high as five to one. Production quantities of chloroform and carbon tetrachloride are limited.

Operating Conditions: Chlorination conditions vary with the product distribution desired, which in turn varies with market conditions. A representative set of operating conditions for the primary chlorination is included in the above text.

Yields: Over-all process yield, methane to chlorinated methanes, is 85-90 percent.

Commercial Installations: This process or a variation is used at the following plants: Allied Chemical and Dye Corp., Solvay Process Division, Moundsville, W. Va.; Dow Chemical Co., Pittsburg, Calif., and Freeport, Texas.

References: PETROLEUM REFINER, **33** No. 12,p136 (Dec. 1954); Hirschkind, W., *Ind. Eng. Chem.*, **41**, p2749 (1949).



Cumene—UNIVERSAL OIL PRODUCTS COMPANY

Application: A process for alkylating aromatics with olefins. Its principal application is in the manufacture of cumene (isopropylbenzene) by reacting propylene with benzene. The process also is used to make ethylbenzene by alkylating benzene with ethylene.

Charge: Propylene-propane mixture and benzene to produce cumene; ethylene-ethane mixture and benzene to make ethylbenzene.

Process Description: The olefin-bearing feed stream should be free of hydrogen sulfide and basic nitrogen compounds before entering the reactor section. The benzene also should be of high purity, but this is not an essential requirement.

Hydrogen sulfide removal from the olefinic stream generally is accomplished by washing with caustic; amine scrubbing may be used, however. The removal of basic nitrogen compounds is best effected by countercurrent washing with fresh water, the pH of which may be controlled by acid injection if desired.

The purified olefinic stock is mixed with the benzene in a combined feed surge drum. The resulting charge is pumped through suitable heat exchangers enroute to the reaction chamber. The catalyst, solid phosphoric acid, is maintained in separate beds in the reactor, suitable propane quench being provided between beds for temperature control purposes, since the reaction is exothermic in nature.

The reactor effluent flows first to a depropanizer, in which propane is separated as the overhead product. Some of this propane is used for quenching; the balance is withdrawn as a net product stream.

The depropanizer bottoms stream passes to the benzene recovery column, where unreacted benzene is distilled overhead. It ultimately combines, as recycle, with fresh benzene in the overhead receiver. The fresh and recycle benzene mixture is then pumped from this receiver to the combined feed surge drum.

A small portion of the recycle benzene stream may be withdrawn periodically to prevent the accumulation of contaminants introduced along with the fresh benzene. However, high purity benzene, such as that produced by the Udex Process, largely eliminates the need to withdraw recycled benzene from the system.

The crude cumene product removed from the bottom of the benzene column is processed in the rerun fractionator as the final manufacturing step. This column produces specification cumene as the overhead product. A minor amount of cumene bottoms also is made.

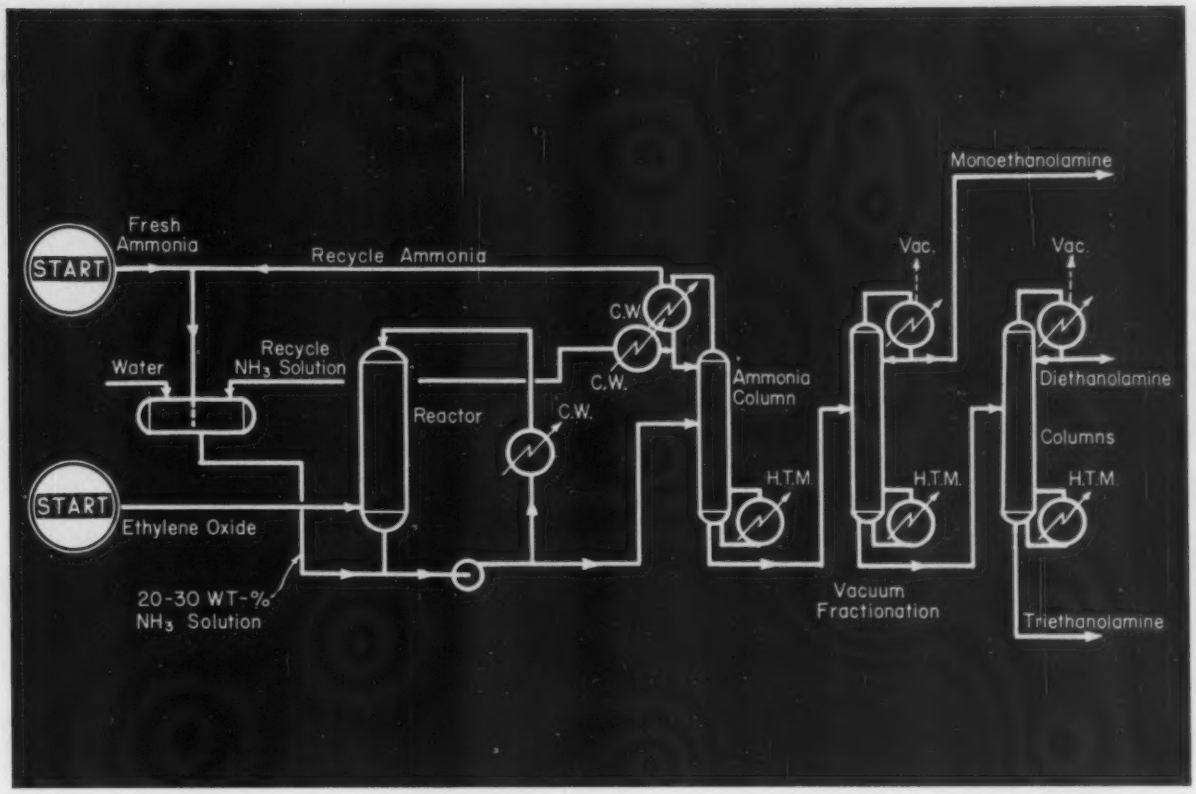
Essentially the same sequence of operating steps is employed in the manufacture of ethylbenzene. However, minor modifications are necessary, as the consequence of the introduction of ethane and other light, non-condensable gases with the olefin feed. Process equipment, arranged for the most part as in the flow diagram shown, also is suitable for making di-isopropylbenzenes and butylbenzenes. Appropriate modifications to the reaction conditions are required to produce these other alkyl aromatics.

Yields: The yields from a typical cumene operation are:

	BPSD
Propane charge	75
Propylene charge	70
Benzene charge	72
Propane product	75
Propylene product	2
Cumene	109
Bottoms	4.5

Commercial Installations: Cumene was initially produced largely as a component for aviation fuel during World War II. Present day operations, however, generally are directed toward the production of high purity (over 99.4 percent) cumene for ultimate use in the manufacture of phenol and acetone. Ethylbenzene of correspondingly high purity is produced by this process and is appropriate for dehydrogenation to styrene. Eight cumene units were operating during World War II. A number of additional units have been installed since then to produce cumene. Others have been constructed to make ethylbenzene.

Reference: PETROLEUM REFINER, Dec'54,p186.



Ethanolamines

Application: A process for the manufacture of ethanolamines.
Charge: Ethylene oxide, 99.5 percent purity; anhydrous ammonia.
Products: Monoethanolamine [$NH_2C_2H_4OH$], 99 wt-percent purity; Diethanolamine [$NH(C_2H_4OH)_2$], 98 wt-percent purity; Triethanolamine [$NN(C_2H_4OH)_3$], 83 wt-percent purity minimum.
Description: Monoethanolamine (MEA), diethanolamine (DEA), and triethanolamine (TEA) are produced commercially by the reaction between ethylene oxide and ammonia. Through control of reaction conditions the distribution of the amines in the product may be varied in accordance with market requirements. In 1956, DEA was in greatest demand; in 1953 MEA was the leader; but in 1951 more TEA was produced than DEA and MEA combined. Thus, commercial plants for the production of ethanolamines must be somewhat flexible with regard to production demands.

Liquid ethylene oxide is charged separately to the reactor. Here it is contacted by a 20-30 wt-percent aqueous ammonia solution in the presence of an excess of recycled reaction product. The reactions are fairly rapid and quite exothermic; in the representative case shown, the reaction mixture is circulated through an external cooler at a high recycle: fresh feed ratio. The makeup ammonia solution is added to the suction of the circulating pump.

The reactor is a vertical steel vessel about half-filled with liquid. Internal packing and auxiliary cooling coils may be used. The reactor contents are maintained at 85-120 F. and about 10-20 psig (some types of reactors are operated at higher pressures). Since ethylene oxide reacts faster with MEA and DEA than with ammonia, careful control of the ethylene oxide: ammonia ratio is exercised. The effect of reactant ratio is shown in the following tabulation.

Weight Ratios of Ethanolamines in Reactor Product

	Moles ethylene oxide/mole ammonia		
	0.1	0.5	1.0
MEA	75-61	25-31	12-15
DEA	21-27	38-32	23-26
TEA	4-12	37	65-59

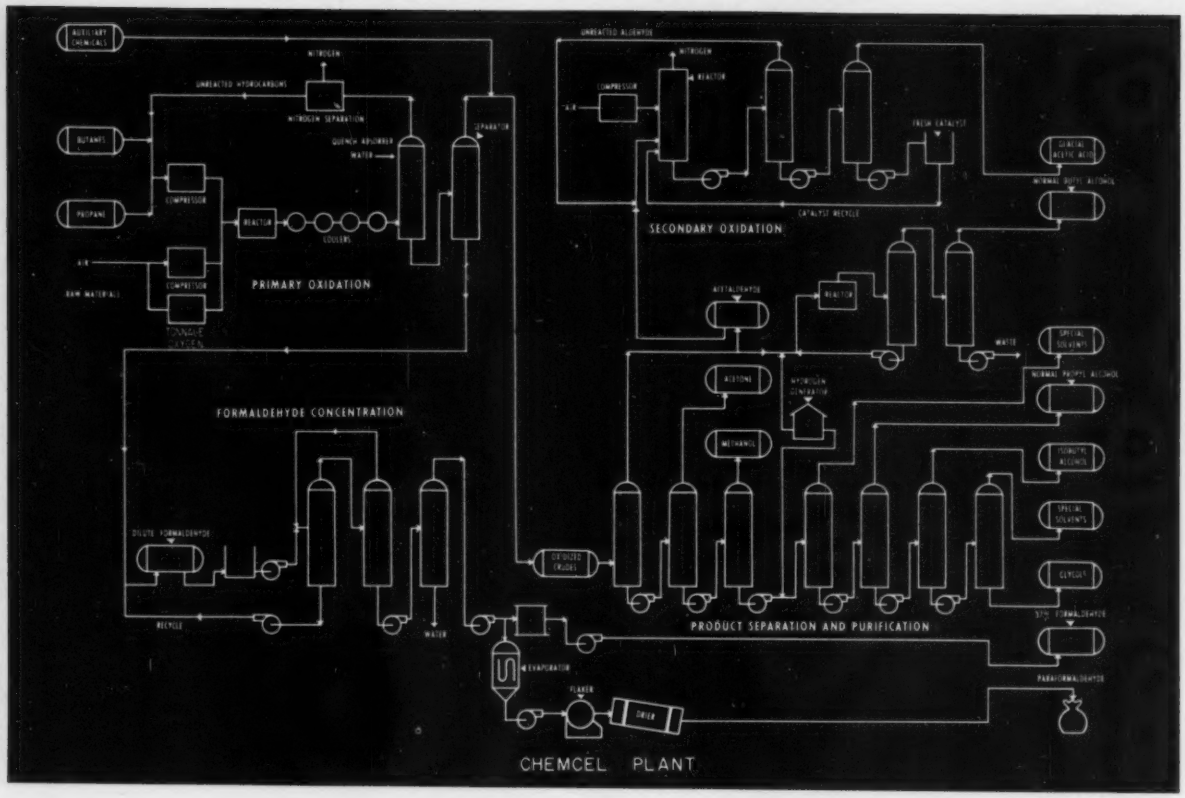
In practice, the ratio will range from 0.1 to 2.0 moles ethylene oxide per mole of contained ammonia, with usual operations employing ratios of 0.3-0.6. Conversion of ethylene oxide is essentially complete, with yields of the desired amines on the order of 95 percent. Some heavy ends are formed, these being principally higher ethylene oxide ethers of TEA.

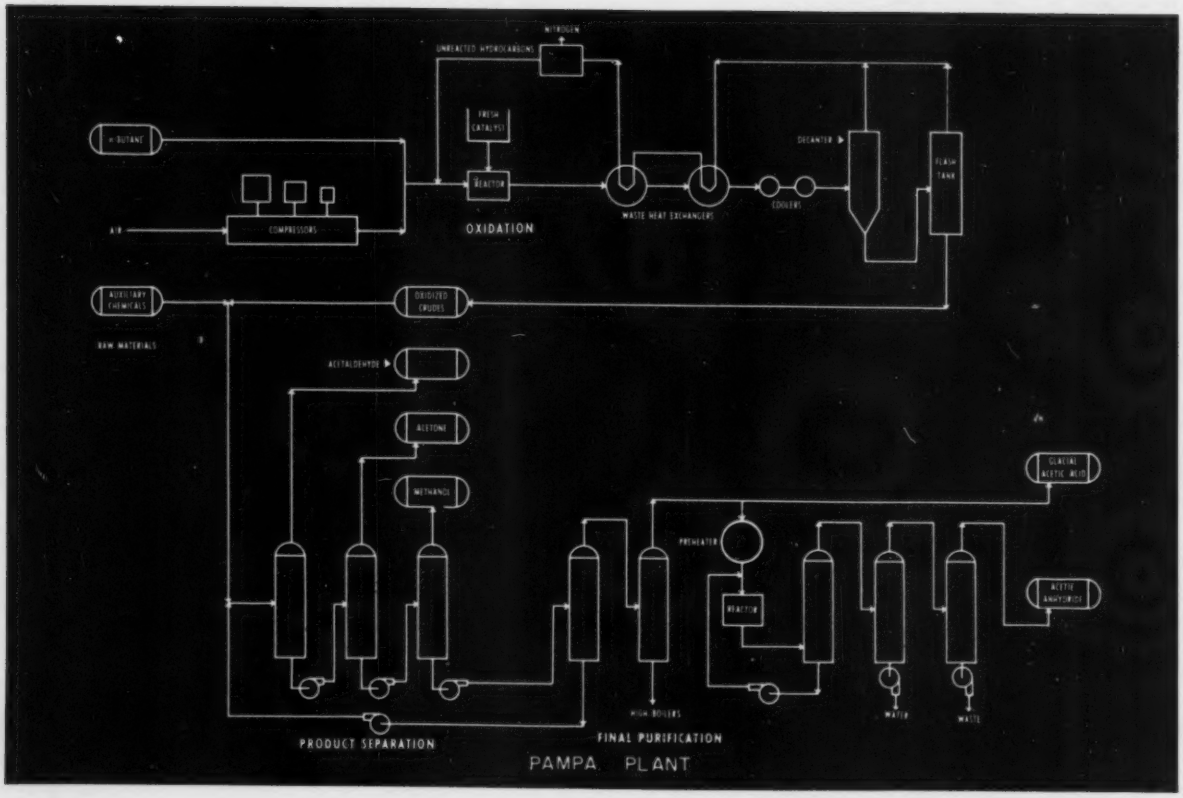
The net reaction product is withdrawn from the circulating pump and fed to an atmospheric distillation column where ammonia and water are removed overhead. These products are returned to the ammonia solution tank where they are blended with fresh ammonia. When operations are such that high yields of TEA are produced, the bottoms from this column may be marketed directly as technical triethanolamine. Otherwise, the bottoms stream is fed to the vacuum distillation columns for further separation.

The vacuum columns are designed for a high degree of flexibility in operation. They are of stainless steel construction, contain 20-30 trays, and are reboiled by high temperature heat transfer medium. The overhead from the first column is 99 percent monoethanolamine product. The overhead from the second column is 98 percent diethanolamine product, with the impurities about equally divided between MEA and TEA. The bottoms from the second column is commercial triethanolamine, which contains some 10-15 percent DEA, 1-3 percent heavy ends, and the remainder TEA. In some cases this material is further distilled to remove heavy ends and thereby improve color.

The ethanolamines are stored conventionally, and shipped from the plant in steel drums and tank cars.

Operating Conditions: Reaction conditions vary with the distribution of the three amines desired; a discussion of this point is included in the above text.
Yields: Over-all process yields of the three amines are on the order of 95 percent, based on both ethylene oxide and ammonia.
Commercial Installations: This process or a variation is used by Carbide and Carbon Chemicals Co., South Charleston, W. Va., and Seadrift, Texas; Dow Chemical Co., Midland, Mich., and Freeport, Texas; Jefferson Chemical Company, Port Neches, Texas; Allied Chemical and Dye Corp., Orange, Texas; Olin-Mathieson Chemical Corp., Brandenburg, Ky.


AUXILIARY CHEMICALS
NITROGEN
UNREACTED HYDROCARBONS
NITROGEN SEPARATION
BUTANES
PROPANE
COMPRESSOR
REACTOR
COOLERS
SEPARATOR
QUENCH ABSORBER
WATER
AIR
RAW MATERIALS
PRIMARY OXIDATION
TONNAGE OXIDES
FORMALDEHYDE CONCENTRATION
DILUTE FORMALDEHYDE
RECYCLE
WATER
OXIDIZED CRUDES
UNREACTED ALDEHYDE
COMPRESSOR
REACTOR
FRESH CATALYST
CATALYST RECYCLE
SECONDARY OXIDATION
GLACIAL ACETIC ACID
NORMAL BUTYL ALCOHOL
ACETALDEHYDE
REACTOR
WATER
SPECIAL SOLVENTS
ACETONE
HYDROGEN GENERATOR
NORMAL PROPYL ALCOHOL
METHANOL
ISOBUTYL ALCOHOL
SPECIAL SOLVENTS
GLYCOLS
37% FORMALDEHYDE
PRODUCT SEPARATION AND PURIFICATION
EVAPORATOR
FLAKER
DRIER
PARAFORMALDEHYDE
CHEMCEL PLANT


NITROGEN
UNREACTED HYDROCARBONS
FRESH CATALYST
n-BUTANE
AIR
COMPRESSORS
REACTOR
OXIDATION
WASTE HEAT EXCHANGERS
COOLERS
DECANTER
FLASH TANK
AUXILIARY CHEMICALS
OXIDIZED CRUDES
RAW MATERIALS
ACETALDEHYDE
ACETONE
METHANOL
GLACIAL ACETIC ACID
PREHEATER
REACTOR
ACETIC ANHYDRIDE
HIGH BOILERS
WATER
WASTE
PRODUCT SEPARATION
FINAL PURIFICATION
PAMPA PLANT

Direct Oxidation of Propane-Butane—CELANESE CORPORATION OF AMERICA

Chemcel Plant

Application: This process is for the production of a number of organic aliphatic oxygenated chemicals and some derivatives from these chemicals.

Charge: Propane and butanes are consumed principally, although some other hydrocarbons would be permissible.

Products: The products are acetic acid, acetaldehyde, formaldehyde in various forms and mixtures with other materials, acetone, alcohols, esters, several glycols and mixtures of alcohols or ketones designated as solvents.

Description. The Chemcel operation, which is continuous, starts with the compression of air for supply both to a tonnage oxygen plant and directly to the oxidation reactor. The oxygen plant employs refrigeration to separate oxygen from nitrogen and trace quantities of other compounds in the air. The specified hydrocarbon gases are compressed separately and an excess of hydrocarbons is used to control subsequent reaction. The separate gas streams are united and fed to the oxidation furnace where partial oxidation of the hydrocarbons in the gas stream occurs. This primary oxidation is effected in a group of identical furnaces, operated in parallel, which provide for preheating the mixture as well as suitable conditions for the reaction. After brief residence in the furnaces, the gas stream, which has become enriched with primary products formed in the hot reaction chambers, is quenched and absorbed in towers containing water. Vented from these absorbers are unreacted hydrocarbons, which are recycled to the compressors for re-use, and nitrogen under pressure which can be used for driving turbines.

At this stage, a separation of the crude water-chemical mixture is effected. Dilute formaldehyde is isolated first and is subsequently concentrated to the usual water solution known as formalin. Some of the formalin is processed, essentially by dehydration, to yield paraformaldehyde and trioxane.

The portion of the water-chemical mixture remaining after formaldehyde removal is subjected to appropriate procedures for separating and purifying the various chemical components consisting largely of alcohols, aldehydes, ketones and oxides. Chemicals emerging from this step are then ready either for marketing or for additional chemical processing to produce up-graded materials.

Multi-purpose aldoling units up-grade a variety of chemicals, with n-butanol, 3-methoxy butanol, and trimethylolpropane in commercial production.

These advanced processing steps include secondary oxidation, hydrogenation and esterification. In these steps, techniques are employed involving simple and azeotropic distillations, fractionation, solvent-type extraction, evaporation, absorption and other unit processes.

Operating Conditions: These do not for the most part involve extremes, but rather entail careful control of pressures, temperatures, rate of feed, catalyst and air-hydrocarbon ratios.

Yields: The operations are inherently flexible in that process equilibria can be controlled to the extent of allowing significant changes to be made in the outputs of the various chemicals.

Commercial Installation: This plant has been in production since 1945 and is located near Bishop, Texas.

Pampa Plant

Application: This process is for the manufacture of various organic aliphatic oxygenated chemicals.

Charge: The charge is primarily normal butane, although some higher hydrocarbons and propane can be tolerated.

Products: The principal products are acetic acid and acetic anhydride. Other products are vinyl acetate, acetaldehyde, acetone, methanol, propionic and butyric acids, and methyl and ethyl acrylates.

Description: Compressed air and butane are fed to vessels where the oxidation of the hydrocarbons takes place. The reaction-product mixture is run through coolers, including a battery of air-type heat exchangers, and then to separators where nitrogen and other gases are released. As this nitrogen is under considerable pressure, it is used to drive turbines in the process. The other component of this gas is the unreacted hydrocarbon material which is recycled to the reactors.

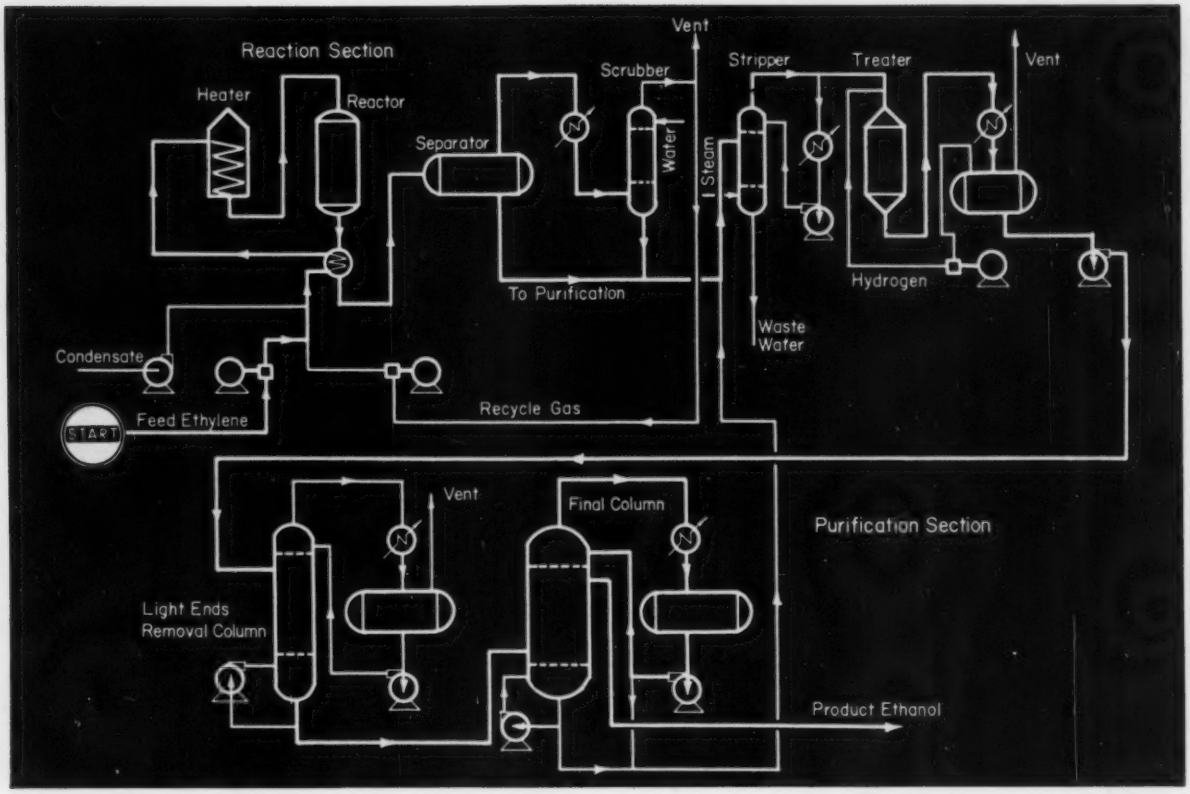
The liquid extract, or oxidized crude, is processed further to effect a separation of acetic acid, the major product, from both relatively lower and higher boiling materials. The acetic acid, after being separated from the oxidized crude mixture is fed to the anhydride unit, which has the capacity for high-efficiency conversion of all acetic acid produced (design capacity 1,800,000 pounds per week) to acetic anhydride. Also at this end of the plant is a vinyl acetate unit with design capacity of more than 30 MM pounds per year and an acrylate ester unit to produce methyl acrylate and ethyl acrylate.

In addition to the main process equipment, a "utility" or "special products" unit is provided. This unit is comprised mainly of reaction and storage tanks and three large fractionating towers together with necessary auxiliary facilities. It is designed for either batch or continuous production and can operate both on co-products from the principal process streams and on large volume specialty products.

In addition to adopting a modified version of the basic process used in the Chemcel plant, a number of changes were made in equipment design. Perforated plate or sieve-type process columns are standard for the plant. Sieve trays were used because they were less expensive initially and are very satisfactory as to operating flexibility, ease of control and quality of product.

Another difference in design of the two plants is the use of air-cooled heat exchangers which are used to handle approximately 80 percent of the total cooling load at Pampa. This reduces the plant's dependence upon the vagaries of the weather in providing water for cooling purposes as the plant is situated in a region of scanty rainfall.

Commercial Installation: This plant has been operating at a location about 6 miles from Pampa, Texas, since late in 1952.



Ethanol—SHELL DEVELOPMENT COMPANY

Application: A process for the manufacture of ethanol.

Charge: Ethylene gas (97 percent purity) and water vapor.

Products: Ethanol 95 volume percent purity.

Description: The reaction section shown is only one of several parallel units making up the plant. The feed ethylene is compressed to approximately 1000 psi in the feed compressor. This stream is combined with the recycle stream from the recycle gas compressor and joined by a controlled stream of water in the ratio of 0.6 moles of water per mole of ethylene. This stream is pre-heated by exchange with the reactor product and totally vaporized in a gas fired furnace and heated to a final temperature of 570 F. before going into the top of the reactor.

The feed passes downward through the catalyst bed (phosphoric acid supported on diatomaceous earth) and a fraction of the ethylene and water is converted to ethyl alcohol on each pass through the reactor. Since the reaction is exothermic, products leave the reactor at slightly higher than the feed temperature.

The reactor product is exchanged with feed, neutralized with caustic soda and separated into liquid and vapor in a high pressure separator. The liquid product goes to the purification section. The vapor is cooled in the recycle gas cooler and scrubbed to remove ethanol. This ethanol-water mixture is sent to the purification section and the gas from the scrubber is recycled. Some of the recycle gas is vented to the ethylene plant to limit concentration of ethane and methane in the reactor feed.

The crude product from the several parallel reactor streams is combined and separated in a low pressure separator. This crude stream is steam stripped, the bottoms going to waste, and the overhead going to the treater. In the treater, the crude stream is combined with a recycle hydrogen stream and, over a nickel catalyst, the trace amounts of aldehydes are converted to the corresponding alcohols.

In the final purification section the light-ends column removes light by-products, principally diethyl ether, and the final column purifies the ethanol.

Reactions: In the Shell hydration process, ethylene and water combine chemically by the reaction:

$$C_2H_4 + H_2O \xrightarrow{H_3PO_4} C_2H_5OH + 19{,}000 \text{ BTU/Lb. Mole}$$

The primary side reaction forms diethyl ether by dehydration of ethanol:

$$2\,C_2H_5OH \xrightarrow{\text{Catalyst}} (C_2H_5)_2O + H_2O$$

Acetylene, present as an impurity in the feed ethylene, forms acetaldehyde:

$$C_2H_2 + H_2O \xrightarrow{\text{Catalyst}} CH_3CHO$$

In addition, a small amount of ethylene polymerizes to form less than one percent of a wide range of olefinic polymers.

The hydrogenation reaction converts the aldehydes to alcohols over a nickel catalyst. In this way acetaldehyde is converted to ethyl alcohol:

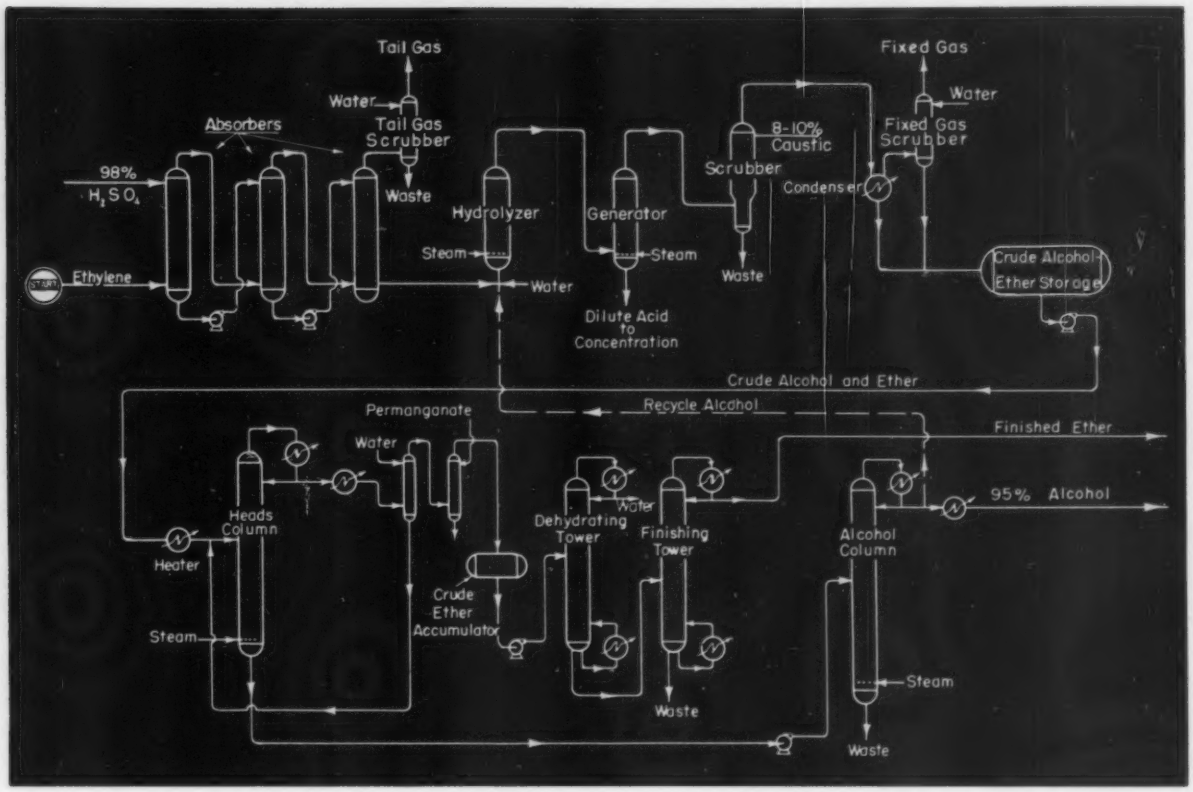
Operating Conditions: The conditions for the ethylene hydration reaction are as follows:

Reaction temperature	570 F.
Reaction pressure	1000 psig.
Reactor feed ethylene concentration, water free basis	85 percent
Ethylene make-up concentration	97 percent
Water-to-ethylene molal ratio in feed	0.6
Space velocity, VSVM	30
Ethylene conversion per pass	4.2 percent
Water conversion	7.0 percent

Yields: Over-all process yield, ethylene to alcohol, is 97 percent or better.

Commercial Installations: This process or a variation is used by Shell Chemical Company at Houston and by British Petroleum Chemicals, Ltd., at Grangemouth, Scotland.

Reference: *Chemical Engineering Progress*, Oct.'54.



Ethyl Alcohol and Ethyl Ether

Application: The esterification-hydrolysis process for the manufacture of ethyl alcohol and ethyl ether.

Charge: Ethylene-rich gas (35-95 percent C_2H_4); concentrated sulfuric acid (98 percent strength).

Products: Ethyl alcohol, 95 volume-percent purity; ethyl ether, 99 weight-percent purity.

Description: A plant designed to produce both ethyl alcohol and ethyl ether by this process can be operated for primary production of alcohol and produce only 5-10 percent of ether or for primary ether production and make little or no alcohol.

The first step is the reaction of sulfuric acid with the ethylene gas stream to form a mixture of ethyl- and diethylsulfates. The size of the absorber varies inversely with acid concentration, ethylene content of the charge gas, and operating pressure. For operating pressures as low as 100 psig and for dilute gas, more than one tower may be required. Internal cooling coils are provided to maintain operating temperatures in the range of 130-170 F.

The absorber tower products flow to the bottom of the hydrolizer where hydrolysis takes place producing alcohol and sulfuric acid. If ether production is desired the alcohol is recycled to the hydrolyzer for longer residence time. The reactions are:

$$C_2H_5OH + C_2H_5HSO_4 \longrightarrow C_2H_5OC_2H_5 + H_2SO_4$$
$$C_2H_5OH + (C_2H_5)_2SO_4 \longrightarrow C_2H_5OC_2H_5 + C_2H_5HSO_4$$

For full ether production, residence times on the order of three hours and temperatures as high as 250 F. are required. The hydrolyzer is a lead-lined steel vessel with inner layer of acid-proof brick.

The tydrolyzate, is pressured to the generator where ether, alcohol, and water are stream stripped from the acid. The dilute acid is sent to concentration. The overhead product passes to a caustic scrubber for neutralization of the sulfuric acid. The generator is of acid proof construction and the scrubber is monel lined. The vapors from the scrubber are condensed and non-condensibles further scrubbed and these combined solutions sent to crude alcohol-ether storage.

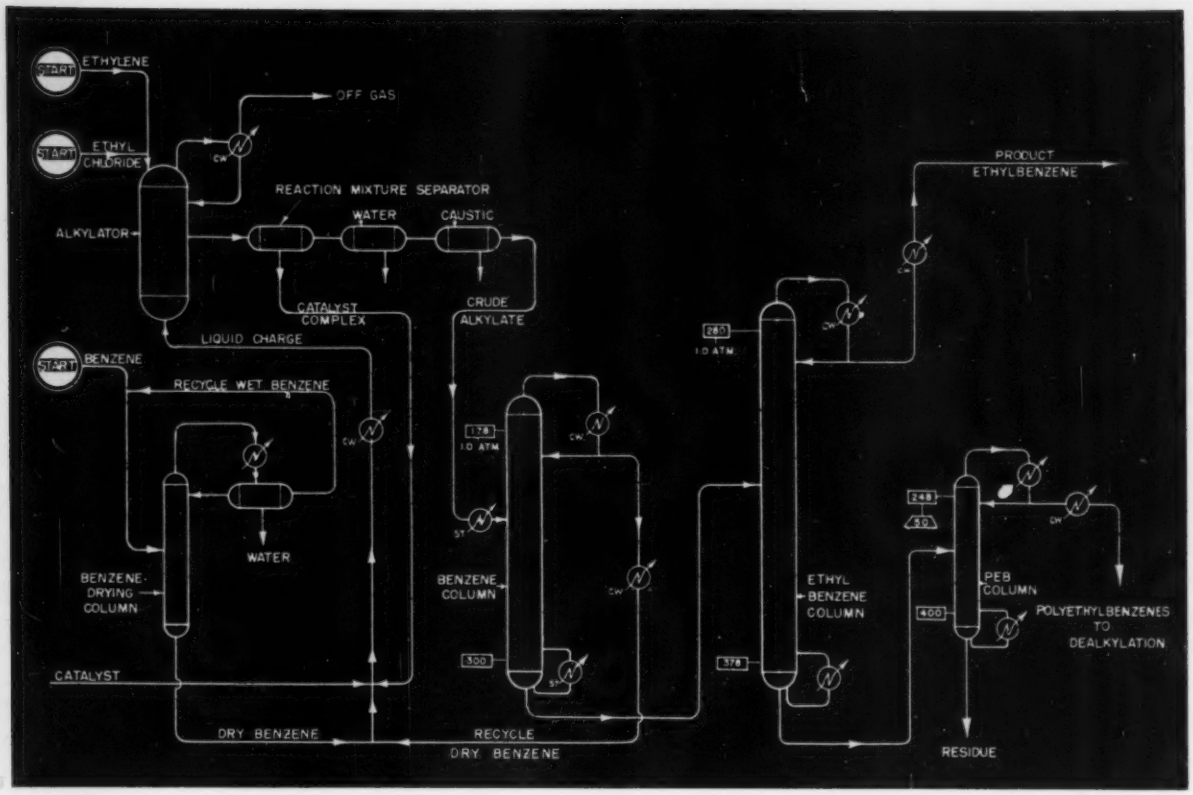
This crude mixture is separated in a heads column, the bottoms going to alcohol column and the overhead going to water wash and permanganate contact and then to crude ether storage.

The ether is finished in a dehydrating tower and a finishing tower. The alcohol is distilled to commercial ethyl alcohol in the alcohol column.

Operating Conditions: These conditions vary with the primary product desired. Some of the ranges are given in the above text.

Yields: 90 percent over-all process yield, alcohol from ethylene.

Commercial Installations: This process or a variation is used at the following plants: Union Carbide Chemicals Co., South Charleston, W. Va., Texas City, Texas, Whiting, Ind.; Esso Standard Oil Co., Baton Rouge, La., Linden, N. J.; National Petro-Chemicals Co., Tuscola, Ill.



Ethylbenzene

Application: A process for manufacturing ethylbenzene.

Charge: Ethylene gas (90-95 mole-percent purity), benzene (styrene grade), anhydrous aluminum chloride, ethyl chloride.

Product: Ethylbenzene liquid (99.5+ percent purity), primarily for use in styrene manufacture.

Description: Benzene of about 99-percent purity is pumped from storage to the drying column where water is removed by azeotropic distillation. Dry benzene contains a maximum of 30 ppm water. This material is mixed with "catalyst complex" and makeup catalyst to form the alkylator charge. The hydrogen chloride, which serves as a promoter, is supplied indirectly from ethyl chloride which is mixed with the ethylene feed.

The "catalyst complex" consists of a mixture of heavy organics and the catalyst, solid anhydrous aluminum chloride of 97-98 percent purity. It is separated from the reaction products and recycled for its catalyst value. In the alkylator ethylene and benzene react to form ethylbenzene. Ethylene gas contacts the charge of benzene, catalyst, and complex in the alkylator at a temperature of 200 F. and a pressure slightly above atmospheric. Ethylene conversion is near-quantitative.

The alkylator is usually a conventional stirred reactor or a packed tower. The reaction is exothermic and means for heat removal must be provided. Conversion of benzene to ethylbenzene is 30-40 percent per pass.

The alkylator effluent is separated from the heavier catalyst complex. It is then washed with water and caustic in separate steps.

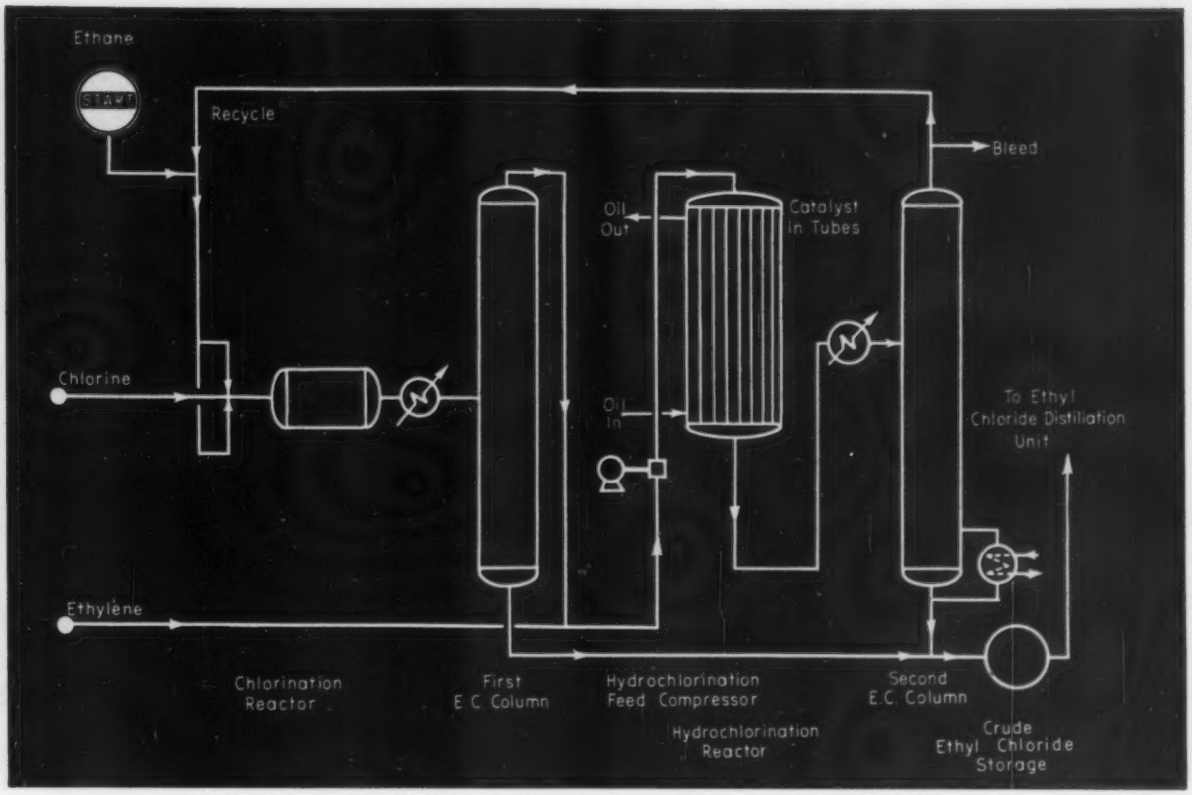
The crude alkylate contains 40-45 percent benzene, 15-20 percent higher-ethylbenzenes, a small amount of tar, and the remainder ethylbenzene. Separation is carried out in a train of conventional fractionating columns. The arrangement of towers described here is only one of several in commercial use. The first column, operating at atmospheric pressure, removes benzene overhead. The bottoms stream passes to the second column in which product ethylbenzene is removed as the overhead stream. This column is usually operated at atmospheric pressure. The third column operates at a head pressure of about 50 mm Hg absolute and removes an overhead product of higher-ethylbenzenes. This material is reprocessed in a dealkylation step.

Over-all process yields are maintained at a high level by the dealkylation step (not shown on the flow diagram) which is similar to the alkylation step, except that higher reaction temperatures and different catalyst ratios are used. The higher-ethylbenzenes are broken down to benzene, ethylbenzene, and diethylbenzene.

Yields: Typical over-all process yields are as follows:

Benzene to ethylbenzene	96 percent
Ethylene to ethylbenzene	97 percent

Commercial Installations: Ethylbenzene units using this process or a variation are found as parts of the several styrene monomer plants throughout the country. Koppers Company recently installed a separate ethylbenzene unit in Port Arthur, Texas.



Ethyl Chloride— SHELL DEVELOPMENT COMPANY

Application: A combination of substitutive chlorination of ethane and hydrochlorination of ethylene for the manufacture of ethyl chloride.

Charge: Ethane, chlorine and ethylene.

Products: Ethyl chloride.

Description: Chlorine, ethane, and recycle gas stream containing ethylene are fed to the chlorination reactor. The combined ethane and recycle are pre-heated. The chlorine enters as a vapor. The reaction is exothermic and is carried out adiabatically. The reactor exit stream is cooled and sent to the first ethyl chloride column where the inerts, unreacted ethane, hydrogen chloride and some of the ethyl chloride are taken overhead. The remainder of the ethyl chloride and other chlorinated by-products leave as bottom product and are sent to crude ethyl chloride storage.

The overhead stream from this first column plus fresh ethylene is compressed, preheated and fed to the hydrochlorination reactor, where 50-80 percent of the ethylene and the hydrogen chloride combine. In this reaction, temperature is a more important variable than it is in chlorination, and the reaction is carried out isothermally, heat being removed by circulating oil.

The hydrochlorinator exit stream is cooled and fed to the second ethyl chloride column where crude ethyl chloride is taken out as bottoms and sent to crude ethyl chloride storage. The overhead consisting of ethane, inerts, unreacted ethylene and hydrogen chloride is recycled to the chlorinator. It is necessary to vent a portion of this stream to prevent buildup of inerts. The crude ethyl chloride is fed to the ethyl chloride distillation unit, where it is purified in a straight-forward manner by passing first through a heavy-ends column and then through a light-ends column.

In the chlorination reaction, the chlorine disappears completely. Some of the ethylene reacts, but some ethylene is formed by ethyl chloride cracking. Moles of HCl formed exceed slightly the moles of chlorine fed.

In the hydrochlorination reaction the addition of fresh ethylene to the gas stream from the first ethyl chloride column is automatically controlled so that the ethylene-to-hydrogen chloride feed ratio is 1:1. This ratio is not critical, but 1:1 appears to be optimum. Since one mole of ethylene reacts with one mole of hydrogen chloride, the ethylene-hydrogen chloride ratios in the reactor exit, recycle, and vent gas streams are also 1:1.

Reactions: The ethane chlorination reaction in this process is carried out in the presence of ethylene at or above 750 F. It produces ethyl chloride and hydrogen chloride:

$$Cl_2 + C_2H_6 \rightarrow C_2H_5Cl + HCl$$

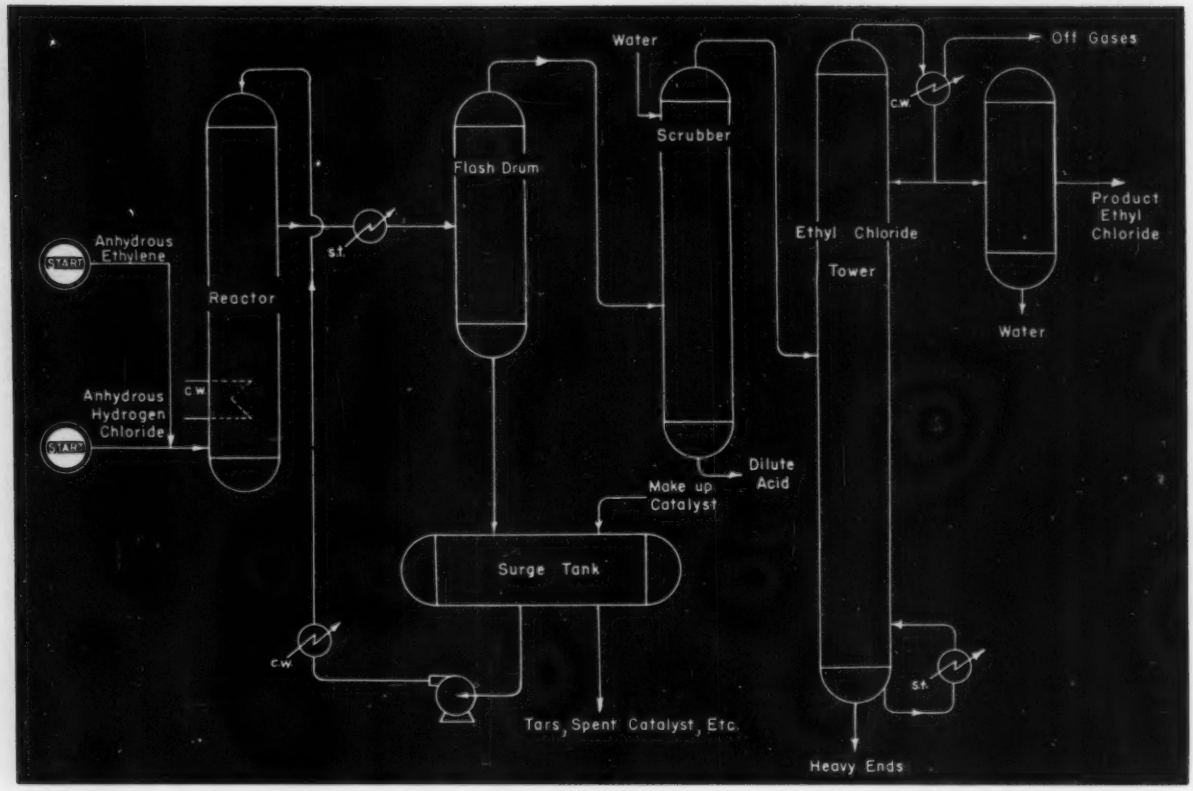
The hydrogen chloride produced in the chlorination reaction is used in the ethylene hydrochlorination reaction which is carried out in the vapor phase at elevated pressure in a reactor packed with catalyst:

$$HCl + C_2H_4 \xrightarrow{\text{Catalyst}} C_2H_5Cl$$

Yields: 90 percent over-all yield, ethane plus ethylene to ethyl chloride, and 95 percent chlorine to ethyl chloride.

Commercial Installation: Associated Ethyl Co., Ltd., Ellesmere Port, Cheshire, England.

Reference: *Industrial and Engineering Chemistry,* Vol. 47,No.5,May'55.



Ethyl Chloride

Application: This is a process for the production of pure ethyl chloride.

Charge: Hydrogen chloride (anhydrous) and ethylene (90-95 percent).

Product: Ethyl chloride, 99 percent minimum purity.

Description: Anhydrous hydrogen chloride and dry ethylene are mixed in approximately equal molecular proportions and charged to the reactor. A frequent source of ethylene for this process is the purge gas stream from a polyethylene unit. The mixed gases at 95-100 F. enter the vertical reactor and pass upward through the catalyst solution, which is a mixture of aluminum chloride in ethyl chloride or in a higher-boiling chlorinated solvent. The hydrochlorination reaction is exothermic and the heat is removed by cooling coils immersed in the reacting mass. A pressure of about 40 psi is required to maintain the reaction products in the liquid phase. The conversion of both reactants is essentially complete and the yield of ethyl chloride is about 90 percent.

The excess liquid in the reactor overflows into a heater and thence to a flash drum. The vapor, equivalent to the net production of ethyl chloride when the product is used as a reaction medium, or to the total production when another solvent is used, is passed to the purification system. The liquid is pumped to a surge tank where aluminum chloride is added as catalyst makeup and the fresh, cooled mixture is pumped to the reactor.

The vapor from the flash drum is primarily ethyl chloride with minor amounts of methane, ethylene, hydrogen chloride, and heavier chlorinated hydrocarbons. A water scrub removes the hydrogen chloride and the organic vapors are fed to the ethyl chloride product tower. In this tower, the non-condensable gases are vented and ethyl chloride and water are the overhead product. The product is dried by decantation and sent to storage.

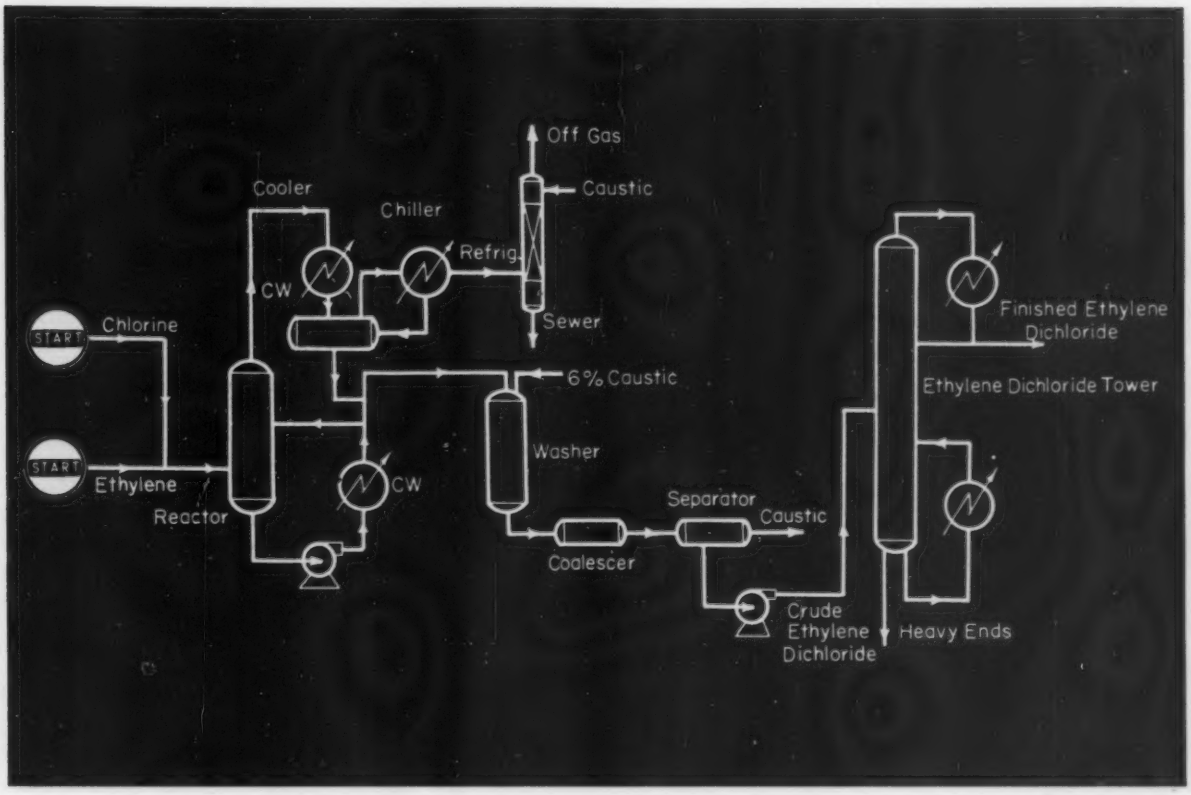
One unique feature of the process is the ease of integration with polyethylene operations. Purge gas from the polymer plant is normally of sufficiently high purity for ethyl chloride manufacture, while the HCl is easily made by direct combustion of chlorine with by-product hydrogen from the cracking plant for ethylene. For these reasons ethyl chloride is becoming a frequent co-product of polyethylene.

Operating Conditions: The reaction conditions given represent a compromise between unfavorable equilibrium conversions at higher temperatures and slow reaction with incomplete conversion at lower levels. The pressure is needed only to maintain the liquid state in the reactor.

Yields: The over-all yields of ethyl chloride is about 90 percent.

Commercial Installations: This process or variations is in use at the following plants: Ethyl Corporation, Baton Rouge, La., Deer Park, Texas; Dow Chemical Company, Midland, Mich., Freeport, Texas; and National Petrochemicals, Tuscola, Ill.

Reference: PETROLEUM REFINER, Dec.'54,p136.



Ethylene Dichloride

Application: A process for the manufacture of ethylene dichloride (1,2 dichloroethane).

Charge: Chlorine, 99+ percent purity; ethylene-rich gas.

Product: Ethylene dichloride, 99+ percent purity.

Description: Ethylene dichloride is produced commercially by the chemical combination of ethylene and chlorine. The ethylene may contain diluents such as hydrogen and methane, but in general should contain no impurities heavier than propane. Frequently, the ethylene has a purity of 90 percent or better.

Ethylene and chlorine are blended in a molar ratio of 1.05-1.10 to 1.00 and charged to the reactor. The reaction takes place in the liquid phase in the presence of a considerable excess of reaction products. The exothermic heat of reaction is removed by circulating the reaction mixture through an external heat exchanger (other means for heat removal, such as internal coils and jacketed walls, may be used). When the ethylene charge is of high purity, the reaction is quite rapid, and the design of the reactor not overly critical. In general, the reactor is a vertical steel vessel half-filled with ethylene dichloride. When inert gases are present, packing or other means may be used to improve gas-liquid contact. Gases are admitted through sparger pipes at the bottom of the vessel.

The reactor contents are maintained at 100-120 F. The operating pressure for a high-purity ethylene charge is on the order of 10-20 psig, but may be higher for more dilute ethylene charge streams. The yield of ethylene dichloride from chlorine is 90-95 percent. The side products include hydrogen chloride, propylene dichloride, and polychloroethanes. It is sometimes feasible to add small amounts of materials such as ferric chloride or ethylene dibromide to increase the yield of ethylene dichloride.

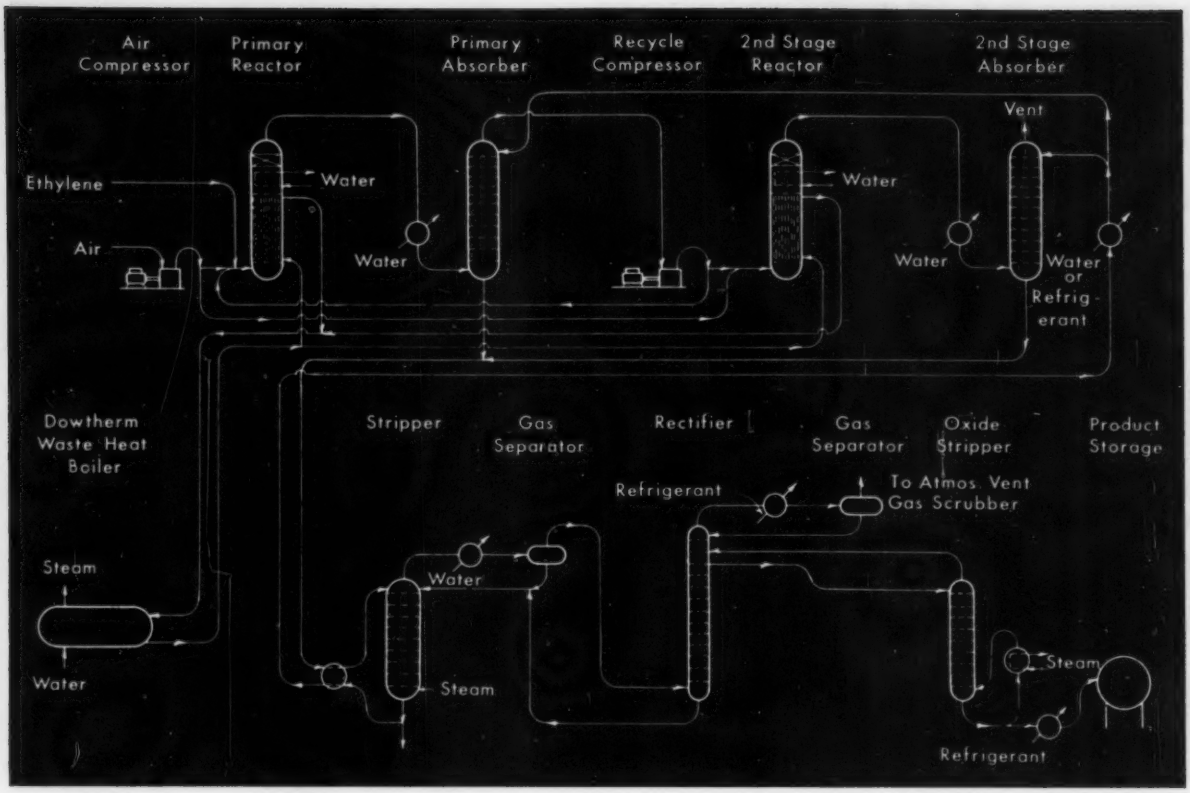
Both vapor and liquid products are removed from the reactor. The vapors pass to water-cooled and refrigerated exchangers for the recovery of ethylene dichloride, and thence to a scrubbing tower where hydrogen chloride is removed with dilute caustic. The vapors finally issuing from the vent contain hydrogen, methane, ethylene, and ethane.

The liquid products from the reactor are washed with 6-8 percent caustic in an agitated vessel. They then pass through a coalescer to a separator tank where the lower layer of crude ethylene dichloride is withdrawn.

Final purification of the ethylene dichloride is accomplished in a conventional atmospheric distillation column. The finished product has a purity of 99+ percent, and is stored in steel containers.

Yields: Over-all process yield of ethylene dichloride from chlorine is 90-95 percent.

Commercial Installations: This process or a variation is used at the following plants: Carbide and Carbon Chemicals Co., South Charleston, W. Va. and Texas City, Texas; Dow Chemical Co., Freeport, Texas and Midland, Mich.; Ethyl Corporation, Baton Rouge, La. and Houston; Monsanto Chemical Co., Texas City; Diamond Alkali Co., Deer Park, Texas.



Ethylene Oxide—THE ATLANTIC REFINING COMPANY—VULCAN-CINCINNATI, INC.

Application: A process for making ethylene oxide.

Charge: Ethylene of 95+ percent purity.

Product: Ethylene oxide of 99.5 percent purity.

Description: Ethylene oxide is made by the direct oxidation of ethylene. Ethylene and air are mixed with recycle gas and passed through a multitube reactor, each tube of which is filled with a fluidized silver catalyst. The tubes are kept full by a layer of catalyst held above the tube sheet. Specially designed orifices assure equal gas distribution. A dowtherm system removes the heat of reaction and gives the required close temperature control. The dowtherm vapors when condensed form steam for the process. The reaction is quenched right after the catalyst bed by internal cooling coils. Filters remove any entrained catalyst from the gases. After further cooling the gases flow to the primary absorber where they are scrubbed with water to extract the ethylene oxide.

The oxide-free gas is recompressed. Part of the stream is recycled to the primary reactor, and part, with a small amount of air added, is fed to the second stage reactor. This reactor, of the same design as the primary, is operated on a once through basis. Exit gases are cooled and then scrubbed with water in the second stage absorber. The oxide-free gas may be vented or go to a third stage.

The absorbates from the two absorbers are combined and fed to the top of a bubble-cap stripping column after heat exchange with the bottoms-stripped absorbent from the stripper. Stripped absorbent is returned to the absorbers. In the stripper column ethylene oxide and other gases are stripped from the absorbate by open steam. A mixture of ethylene oxide, water and carbon dioxide goes overhead to a partial condenser where water is separated and refluxed to the stripper.

The uncondensed vapors are fed to a rectifying column. The bottoms stream is returned to the stripper as reflux. The overhead stream is partially condensed. The condensate is refluxed, and the uncondensed gases are sent to an atmospheric vent gas scrubber for recovery of any ethylene oxide present in the gas.

A sidestream from the column, containing the ethylene oxide product and carbon dioxide, is fed to the oxide stripper where the carbon dioxide is removed overhead. This stream is returned to the rectifying column, and the bottom stream, the ethylene oxide product, is cooled and sent to storage in spheres under inert gas.

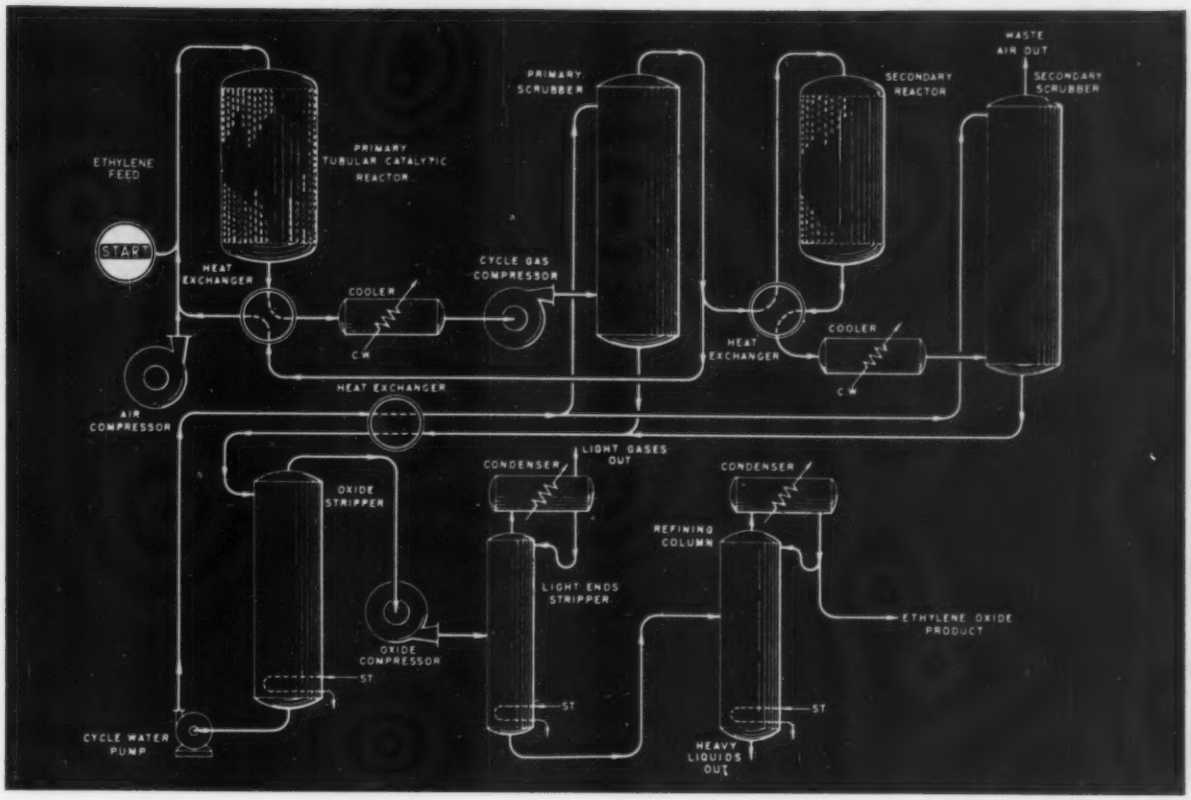
The catalyst is a specially prepared silver catalyst with good fluidization characteristics. No regeneration or reactivation of the catalyst is needed, and in the captive fluid bed no attrition problem has yet appeared. The reactions involved are simple.

$$(1)\ C_2H_4 + \tfrac{1}{2}\,O_2 \rightarrow C_2H_4O$$
$$(2)\ C_2H_4 + 3\,O_2 \rightarrow 2CO_2 + 2H_2O$$

High temperatures favor reaction (2), and close temperature control is necessary to avoid local hot spots.

Operating Conditions: Reaction temperatures are 400 to 600 F. Pressures are 100 to 150 psig.

Yields: The over-all yield of ethylene oxide is 55-65 percent, based on ethylene. At the present the economic yield is closer to 55 percent. Conversion in the primary reactor is 35-50 percent and in the second 50-70 percent.



Ethylene Oxide— SCIENTIFIC DESIGN COMPANY, INC.

Application: A process for the manufacture of ethylene oxide.

Charge: High purity ethylene and air.

Product: High purity ethylene oxide, liquid.

Description: Compressed air, ethylene, and recycle gas are mixed and fed to a multi-tubular, catalytic reactor. The temperature of oxidation is controlled by an organic cooling medium which is omitted on the process flow diagram. From the reactor the effluent gasses, which contain ethylene oxide, are cooled and further compressed. The cooling is accomplished first by recuperative exchange with the recycle gases, and finally by a water cooled exchanger. The gases then pass to a scrubber where ethylene oxide is absorbed in a dilute aqueous solution. Most of the unabsorbed gases are returned to the reactor via the previously mentioned recuperative exchanger, thus completing a closed circuit. A portion is diverted to the secondary reactor, to purge accumulated inert gases. The secondary reactor operates to scavenge the remaining ethylene. From the secondary reactor the effluent gases are cooled as before. The ethylene oxide is absorbed in a scrubber, and the residual gases are discharged from the system.

The dilute solution of ethylene oxide is stripped by heat. A feed-bottoms exchanger is usually employed to save steam. The overhead vapor, which contains a substantial amount of water vapor, may be passed through a partial condenser for enrichment. This partial condenser is omitted on the flow diagram, because it is not essential and because of space limitations. Oxide vapor is compressed and refined in a distillation train. There are several alternate arrangements for the distillation. As shown here, the carbon dioxide and other light ends are first stripped out of the oxide, and then pure oxide is distilled away from water and other heavier liquids. The pure ethylene oxide product is pumped as a liquid to storage tanks which are padded with inert gas.

The catalyst contains silver. Its long life and durability make catalyst costs a relatively unimportant item in the ethylene oxide manufacturing budget. The reactions involved are simple:

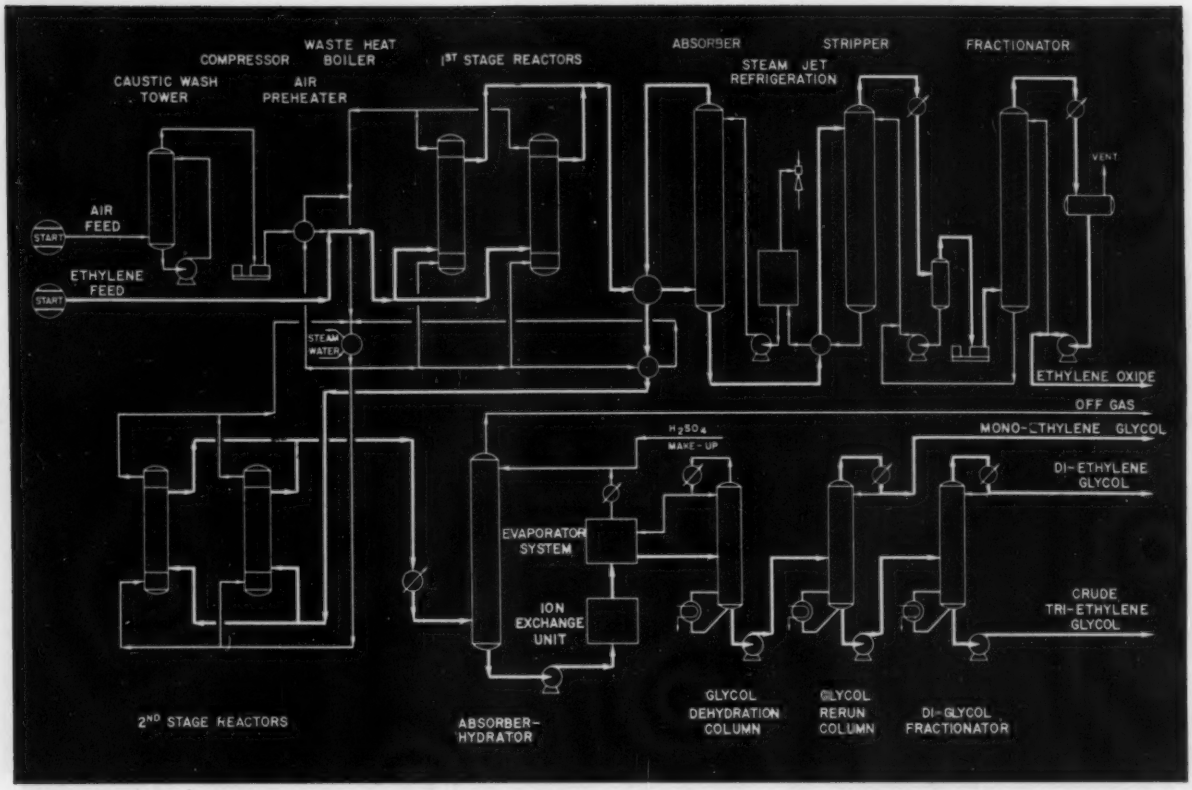
$$(1)\quad C_2H_4 + \tfrac{1}{2}O_2 \rightarrow C_2H_4O$$
$$(2)\quad C_2H_4 + 3\,O_2 \rightarrow 2\,CO_2 + 2\,H_2O$$

Operating Conditions: Oxygen and ethylene concentrations in the reaction gases are quite critical. In order to avoid explosion hazards, they must be maintained at a low level. Reaction temperatures range between 450 F and 600 F. The reaction pressure may vary between 120 and 300 psig. Distillation conditions are usually determined by the available cooling water temperature.

Yields: The weight yield, expressed as pounds of ethylene oxide produced per pound of ethylene consumed, approaches one hundred percent, in plants of the proper design.

Commercial Installations: Two plants are in operation: Nitrogen Division of Allied Chemical and Dye Corp., Orange, Texas, and Napthachimie, Lavera, France (now being expanded). In design or construction: General Aniline and Film Corp., Linden, N. J.; Societe Chimiques des Derives du Petrole, Antwerp, Belgium; Mitsui Petrochemical Industries, Ltd., Iwakuni City, Japan; Farbenfabrik Bayer, Dormagen, Germany; Marles-Kuhlmann, Gourfreville, France; Jefferson Chemical Co., Port Neches, Texas; and another undisclosed company.

References: PETROLEUM REFINER, Sept. '53,p146; *Chemical Engineering*, Aug.'54,p130.



Ethylene Oxide and Ethylene Glycol—STONE & WEBSTER ENGINEERING CORP.

Application: The process produces ethylene oxide by the direct oxidation of ethylene over a silver catalyst. The ethylene oxide is recovered as a pure product or hydrated to ethylene glycols.

Charge: High purity ethylene and air or oxygen.

Products: High purity ethylene oxide, mono and diethylene glycols and polyglycols.

Description: The air is scrubbed with caustic to remove impurities harmful to the catalyst and compressed to reactor operating pressure. It is then preheated by exchange with Dowtherm from the reactor cooling system, mixed with the ethylene feed and charged to the first stage reactors. The reactor effluent is immediately cooled and passed to an absorber where the ethylene oxide is scrubbed out with water. The rich solution flows to a stripper where the oxides are released overhead. The stripped gases are compressed and passed to a fractionator where ethylene oxide meeting commercial specifications is recovered. Water from the bottom of the stripper is cooled by exchange and subcooled by steam jet refrigeration before its return to the absorber.

The gases from the first oxidation stage are brought again to reaction temperature level by heat exchange with the reactor coolant and charged to the second stage reactors operating at a somewhat higher temperature than the first stage reactors in order to effect high conversion of the remaining ethylene. The reactor effluent is cooled and passed to the hydrator for the catalytic hydration of the oxide to ethylene glycols in dilute solution.

The glycol solution is passed through an ion exchange unit to remove the acid catalyst, and the glycols are concentrated by multiple effect evaporation. The glycol concentrate is then subjected to distillation in a series of fractionating columns; the first removing residual water which is recycled to the evaporators; the second recovering monoethylene glycol as overhead; and the third recovering diethylene glycol as overhead product and the higher glycols as a bottom stream.

The key to the successful operation of this process lies in close temperature control of the reaction and in proper allowance in the reactor design for piston flow and the rate controlling processes of diffusion.

The principal reactions occurring are:

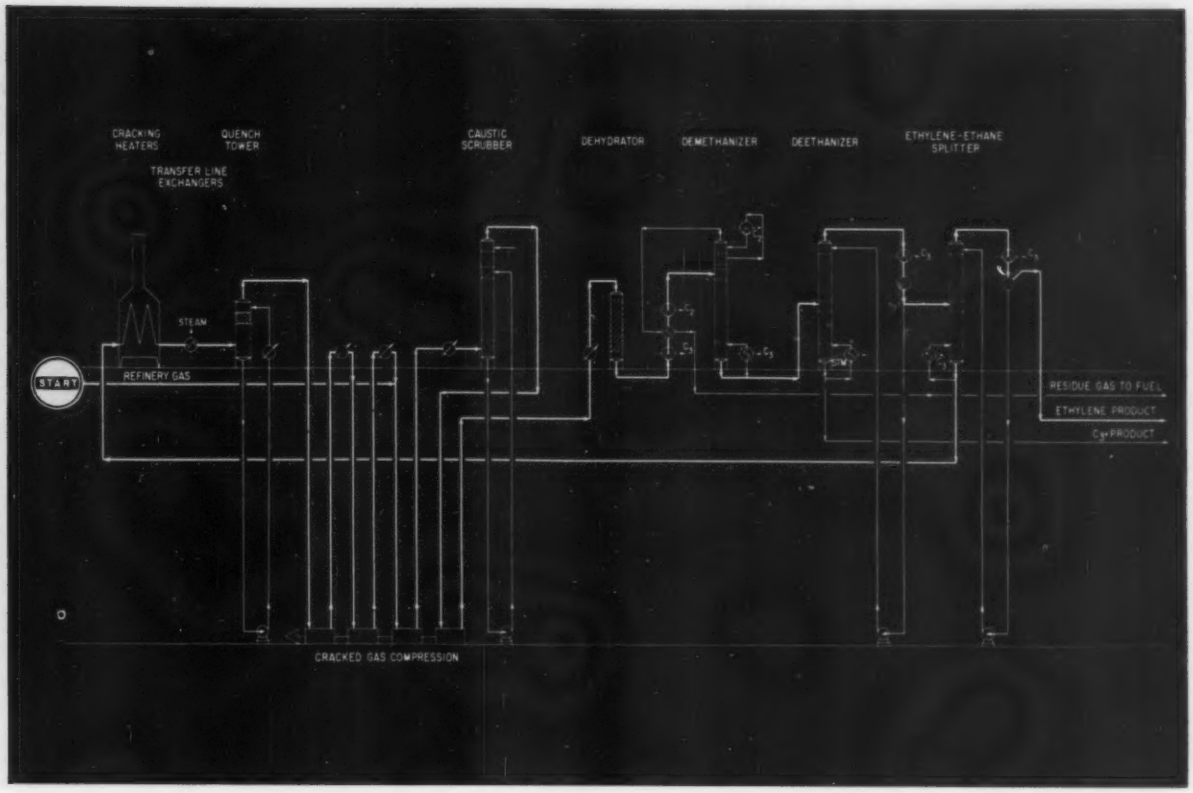
$$C_2H_4 + 3\,O_2 \longrightarrow 2\,CO_2 + 2\,H_2O\ (g) + 570{,}000\ \text{Btu/mole}$$
$$C_2H_4 + \tfrac{1}{2}\,O_2 \longrightarrow C_2H_4O\ (g) + 63{,}000\ \text{Btu/mole}$$

The oxidation catalyst is the Cambron silver catalyst developed by the National Research Council of Canada over the last decade. It has a long life and can be reactivated if accidental poisoning occurs. The catalyst activity is not affected by repeated interruption of operation.

Operating Conditions: The first stage reactors operate at about 500 F., and the second at about 525 F.

Yields: Over-all conversion of ethylene to ethylene oxide is about 63 percent, with a total conversion of ethylene of about 95 percent. Glycol yields depend on the desired conversion of ethylene oxide to glycols.

Commercial Status: The process has been evaluated in the pilot plant and commercial plant design factors have been established.



Ethylene Production—STONE & WEBSTER ENGINEERING CORPORATION

Application: A process for the production of ethylene from various distillate or gaseous feed stocks.

Charge: Naphtha, gas oil, refinery gas, ethane, propane, or butane may be charged.

Products: The primary product is high purity ethylene. Other products are:

- Residue gas, substantially hydrogen and methane.
- A liquid fraction which may be further fractionated.

Description: The recovery process utilized may be either low temperature fractionation, low temperature absorption or adsorption, depending on the composition of the feed gas to the recovery section and the quantity of inerts. This description is based on low temperature fractionation with ethane cracking.

Refinery gas is combined with gas from the cracking furnaces and compressed to the pressure required by the demethanizer. This pressure will vary with the concentration of hydrogen and methane and the recovery of ethylene desired. The compressed gas is cooled, dried and fed to the demethanizer wherein methane and lighter components are taken overhead by fractionation at low temperature. Reflux is produced with ethylene refrigerant.

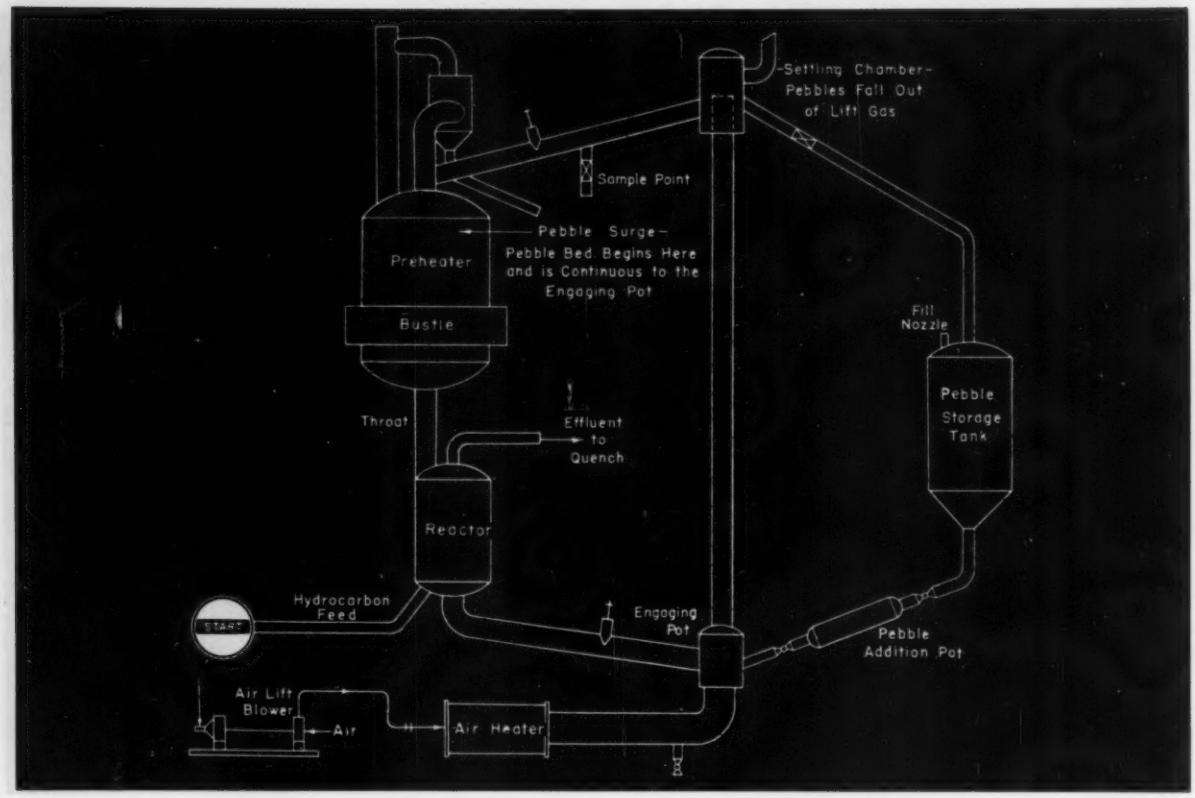
The demethanized bottoms flow to the deethanizer, from which ethylene and ethane are taken overhead, and propylene and heavier discharged as a bottoms stream. This stream may be further separated in a depropanizer, and the recovered propylene-propane cut processed for removal of propylene. The unreacted propane can then be returned to the ethylene unit and cracked to produce additional ethylene. The ethylene-ethane stream is fractionated at low temperature to produce an ethylene product of the required purity and an ethane stream which is vaporized and recycled to the cracking furnaces. Cracking is preformed in a coil-type reactor designed for graduated heat intensity in conformity with a temperature gradient conducive to maximum ethylene yield and minimum coke formation. The furnace effluent is quenched and cooled in a quench tower in which heavy aromatic oil is condensed and separated.

Where an ethylene product with low acetylene content is required, the cracked gas, after compression to an intermediate pressure, is heated and selectively hydrogenated over a catalyst. The gas is then cooled, combined with the refinery gas fresh feed stream and compressed to the final discharge pressure. Refrigeration is by a propane-ethylene cascade system.

Yields: Ultimate yields of ethylene from cracking of C_2 and C_3 are approximately 77 and 45 percent by weight, respectively. Ethylene recovery ranges from 96 to 98 percent. Ethylene product purity normally is in the range of 95 to 99.9 percent.

Commercial Installations: Nineteen plants with a combined production of over 4 million pounds per day of ethylene, and five plants under construction.

Reference: PETROLEUM REFINER, July'54,p135.



Ethylene with Pebble Heater—PHILLIPS PETROLEUM COMPANY

Application: A heating process for attaining temperatures beyond the range of conventional tube furnaces.

Charge: The charge may be gaseous hydrocarbons, inert or corrosive gases, steam or air. It is primarily C_2 to C_4 hydrocarbons for ethylene manufacture.

Product: Ethylene and other unsaturated hydrocarbons, predominantly olefinic. However, the cracked hydrocarbon effluent depends on the processing conditions, i.e., reaction time, pressure and temperature.

Description: In the Pebble Heater process, continuously circulating refractory balls (pebbles) are contacted directly in a reaction chamber with the charge material to be heated or cracked. As shown by the flow diagram, a continuous bed of pebbles extends from the engaging pot upward through the reactor and preheater vessel into the pebble surge at the top of the preheater. This entire bed of pebbles slowly moves downward through the chambers at a rate controlled by a flow control device in the engaging pot. In the lift line the pebbles travel upward in a stream of heated air. The pebbles settle out of the lift air in an enlarged vessel at the top of the lift line and then run down the sloping line to the top of the bed in the pebble surge. As the pebble bed moves downward in the preheater, the pebbles are heated by an upward flow of hot combustion gases. These hot gases are generated under pressure in the bustle-type combustion chamber surrounding the lower portion of the preheater vessel. The hot pebbles then pass through a restricted throat into the reaction chamber where the upward-flowing gaseous charge is heated. The feed is admitted to the lower portion of the reactor through a distributor designed to minimize interference with the flow of pebbles. The resulting cooled pebbles flow downward out of the reactor through a duct into the engaging pot and are returned through the lift to the settling chamber. When processing hydrocarbons the heated gases pass out the top of the reactor into a quench vessel where the temperature may be quickly lowered by direct water spray.

To prevent the undesirable mixing of combustion gases and reactor effluent, a pressure balance is maintained across the throat between the preheater and the reactor. Further to insure separation of the gases, steam is injected into the throat between the chambers. Between the reactor and the engaging pot a steam seal is used to separate the lift gas from the reactor feed.

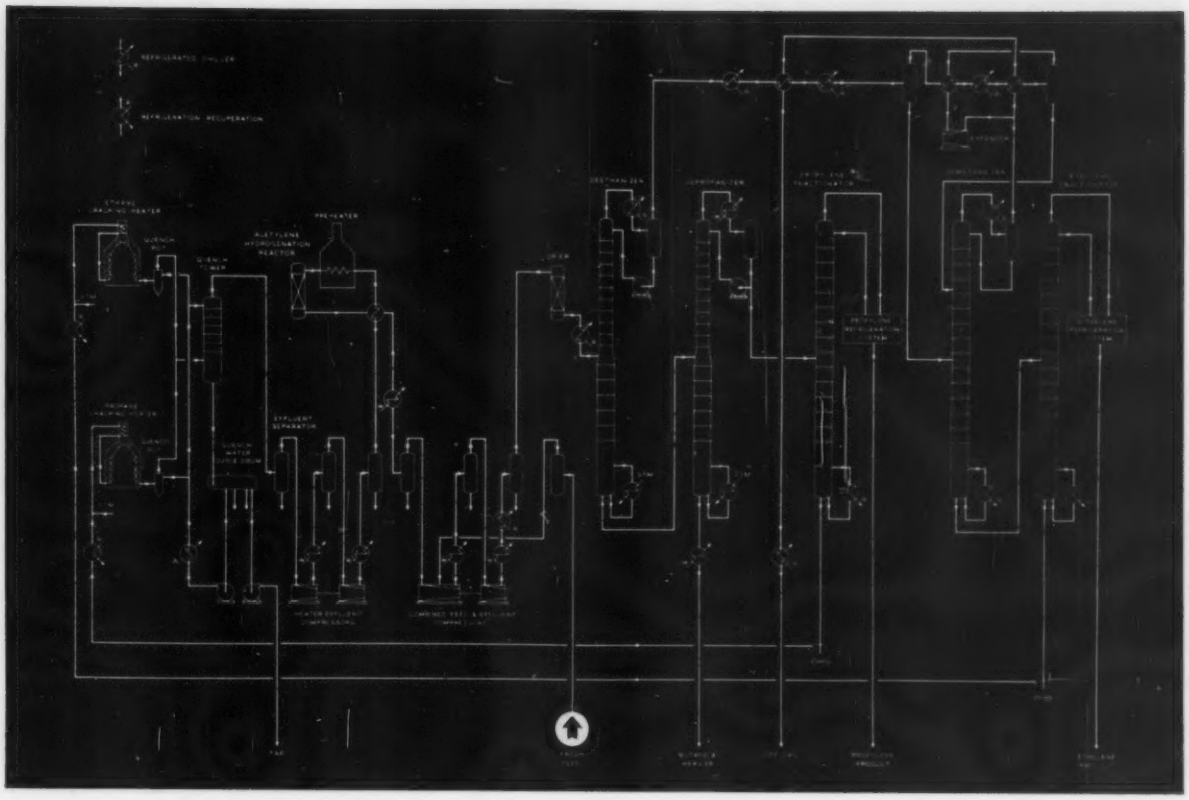
Operating Conditions: The major operating variables for hydrocarbon processing are temperature, pressure and reaction time. For other materials not all of these variables may be significant.

Yields: Typical feed stock and corresponding reactor effluent compositions are as follows:

Feed	(Mol. Percent)	Reactor Effluent	(Mol. Percent)
		Hydrogen	45.0
Ethane	91.0	Methane	7.6
Propane	8.9	Acetylene	3.8
Other	0.1	Ethylene	33.3
		Ethane	7.0
	100.0	Heavy Unsaturates	3.3
			100.0

Commercial Installations: Following several years of successful pilot plant operation, Phillips has installed a 30 Mm Btu per hour commercial Pebble Heater at Borger, Texas.

Reference: PETROLEUM REFINER, Apr.'54,p171.



Ethylene and Propylene—THE LUMMUS COMPANY

Application: A process for the production, recovery and purification of ethylene and propylene.

Charge Stock: Refinery gases, ethane or propane.

Products: Ethylene and/or propylene at the desired purity up to 99.9-mole percent.

Description: The flow diagram illustrates a plant to produce ethylene and propylene from ethane and propane, and to recover these olefins.

Ethane and propane entering as fresh feed plus unconverted ethane and propane are recovered to provide the feed to the cracking heaters.

Separate furnaces are used for cracking ethane and propane in order that each be cracked at the optimum conditions for maximum yield and on-stream time. The effluents from the furnaces are quenched with water in separate quench pots to 600 F., combined and further cooled in water scrubbing tower before introduction to the compression system. Polymer and aromatic distillate are collected in the quench water surge drum and decanted there.

When the ethylene must be acetylene-free, the acetylene is selectively hydrogenated by passing the cracking heater effluent over a catalyst, generally after the second compression stage.

The combined heater effluent and fresh feed is compressed to approximately 500 psig, chilled, and dried over solid desiccants such as activated alumina or bauxite. The dryers consist of multiple desiccant chambers which are regenerated on a predetermined cycle.

The dried feed gas is further chilled and introduced into the deethanizer operating at 450 psig. Hydrogen, methane, ethane and ethylene are taken overhead and propylene, propane, and C_4 and heavier bottoms are charged to the depropanizer. The deethanizer overhead is then chilled by exchange and ethylene refrigeration to —130 F. The remaining vapor is further chilled to about —195 F. The condensed liquids are charged to the demethanizer. The residual vapor is expanded in a centrifugal expander to the fuel gas system pressure. The low temperature produced in the expander is used to produce the final cooling of the feed gas to —195 F.

The demethanizer overhead goes to fuel and the bottoms, (recovered ethane and ethylene), is charged to the ethylne fractionator operating at about 60 psig. The ethylene fractionator is integrated with the ethylene refrigeration system for reflux and reboil heat. The ethylene product is taken overhead and the ethane bottoms are recycled to the ethane heater.

The depropanizer takes propylene-propane overhead and C_4 and heavier as bottoms. The propylene-propane is charged to the propylene fractionator operating at about 20 psig. Propylene products is taken overhead and propane bottoms are recycled to the cracking heater or withdrawn as LPG.

Refrigeration for the unit is supplied by centrifugal compressors operating in a cascade system.

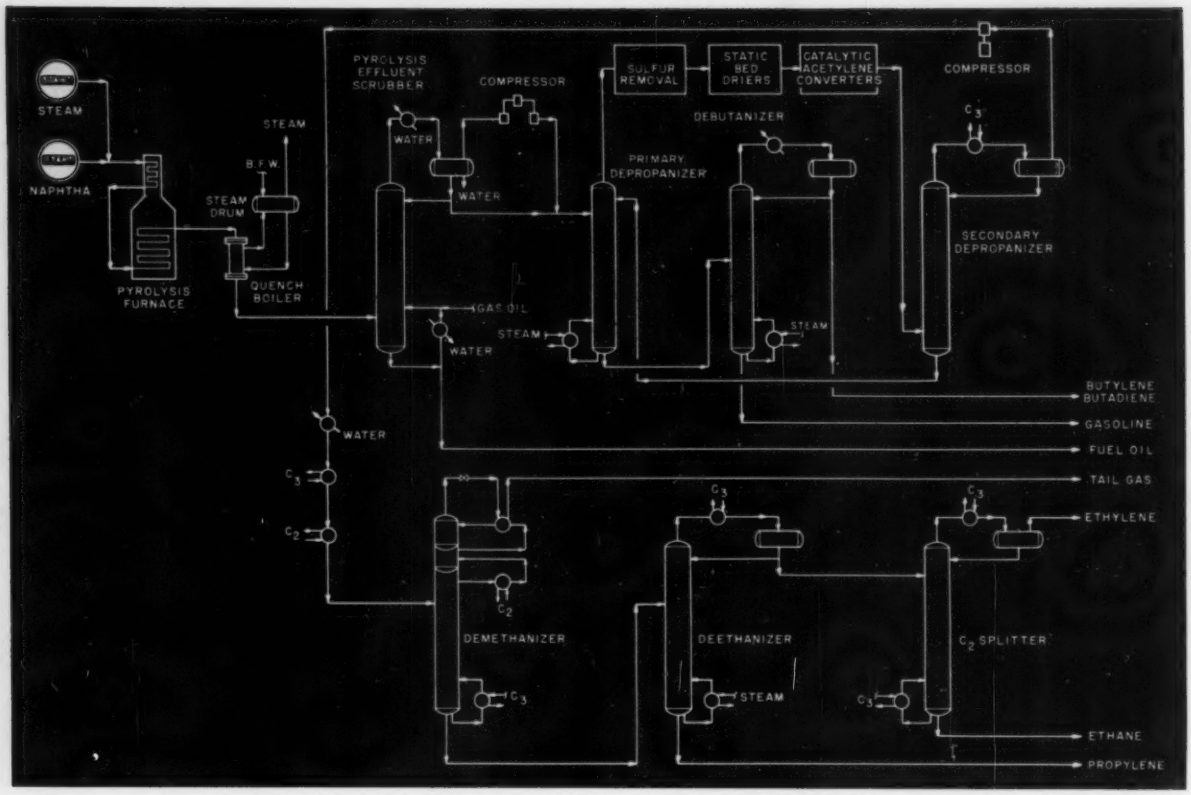
Yield: One million SCF of refinery feed gas gives yields as follows:

Refinery Gas	Volume Percent	Product Pounds
Hydrogen plus inert	7.4	———
Methane	28.5	———
Ethylene	9.9	32,200
Ethane	33.9	———
Propylene	3.3	7,800
Propane	13.4	———
C_4 and heavier	3.6	8,900
Fuel Gas	———	855,000 SCF

A modification of the fractionation system shown above permits the manufacture of ethylene and propylene from naphtha charge stocks. Ethylene of purities to 99.9 volume percent may be produced with this system.

Commercial Installations: The Lummus Company has designed and constructed ten units producing ethylene and/or propylene from various feed stocks.

Reference: PETROLEUM REFINER, July,'54,p135.



Ethylene—THE M. W. KELLOGG COMPANY

Application: A process for the production of ethylene by the steam pyrolysis of petroleum feeds.

Charge: Refinery gas, ethane, propane, butane, pentane, natural gasoline, light and heavy naphthas, gas oil and heavier fractions.

Products: Ethylene in purities up to 99.9 mol percent also valuable olefinic and aromatic products in addition to a tail gas consisting of hydrogen and methane.

Description: The flow diagram illustrates a typical low temperature fractionation unit for producing ethylene from a naphtha charge stock. Naphtha and steam pass through the high temperature coils in the pyrolysis furnace, where cracking takes place.

The cracked products are partially cooled in steam generating facilities before final cooling in a scrubber column from which a fuel oil fraction is withdrawn.

The overhead, consisting of gasoline and lighter components, is compressed and charged to a split depropanizer system from which propane and lighter components are separated from butane and heavier. Sulfur removal, drying and acetylene conversion also take place in the split depropanizing step.

The depropanized bottoms flow to a debutanizer from which C_4's are withdrawn as an overhead product and gasoline as a bottoms product.

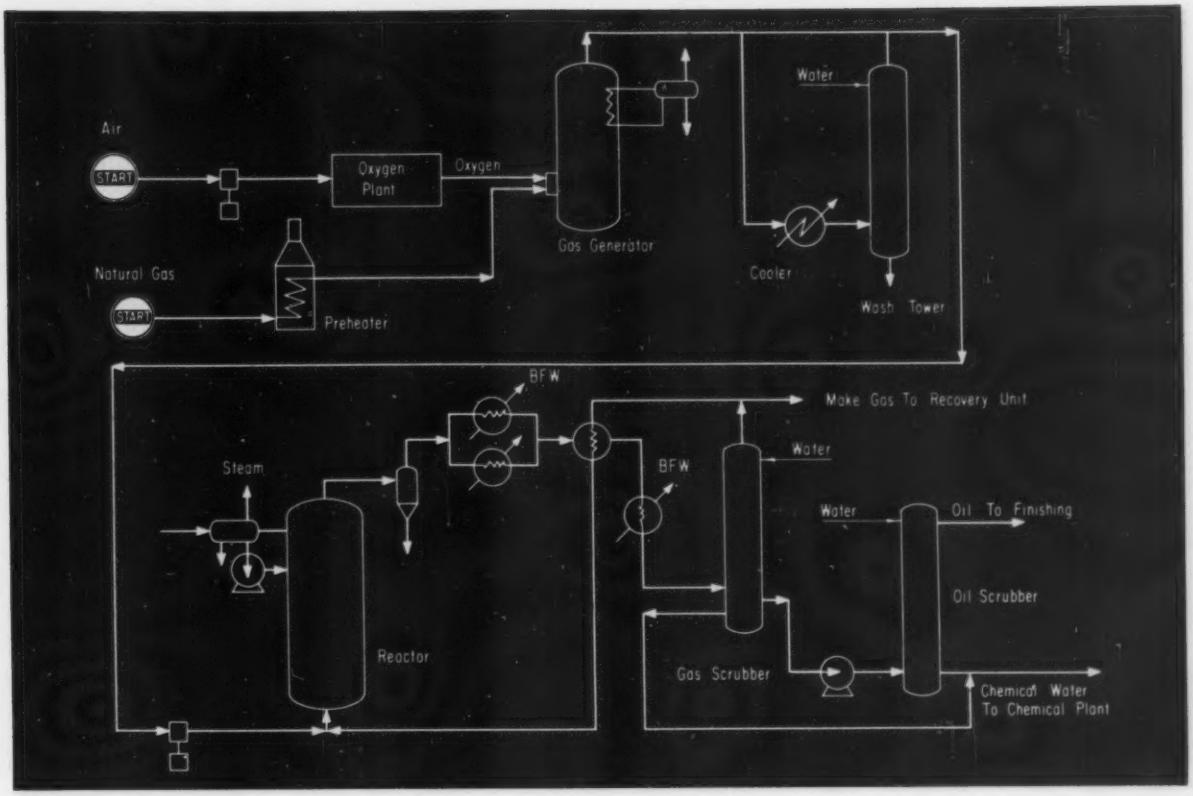
Depropanizer overhead is compressed and sent to the demethanizer where methane and hydrogen are removed as an overhead product by low temperature fractionation. The demethanizer bottoms flow to the de-ethanizer from which the C_2's are separated from the bottoms C_3 product.

The C_2 stream is separated by low temperature fractionation into an ethylene product stream and an ethane product stream which could also be vaporized and cracked to yield additional ethylene.

Refrigeration is supplied by an external propylene-ethylene cascade system and also by gas expansion.

Yields: Ethylene yields of 25 weight percent may be produced in the naphtha pyrolysis furnace effluent. The ethane produced from this pyrolysis could also be cracked to yield approximately 4 additional weight percent ethylene. The C_3 product fraction consists of 90 to 95 percent propylene thereby eliminating the need for propane-propylene splitting. The C_4 fraction is over 95 percent unsaturated and contains a high percentage of butadiene. A high octane gasoline product is also produced in this process.

Commercial Installations: Twelve plants have been designed and built or are being built to yield a total production of approximately 4 million pounds per day of ethylene.



Fischer Tropsch—AMOCO CHEMICALS CORPORATION

Application: A process for synthesizing hydrocarbons and oxygenated chemicals.

Charge: Natural gas and air. It is desirable to use natural gas which is free from sulfur compounds.

Products: There are a large number of products from the process. The liquid product includes both water and hydrocarbon phases. The vapor product, in addition to reactant hydrogen and carbon monoxide, contains ethane, ethylene, propane, propylene and carbon dioxide. The water phase product contains a large number of oxygenated chemicals, the major ones being ethanol, acetic acid, acetone and n-propanol. The hyrocarbon phase is made up largely of normal olefinic hydrocarbon but also contains considerable quantities of C_4 and heavier acids, alcohols, ketones, aldehydes and esters. The hydrocarbon phase can be converted readily into a premium gasoline.

Description: The process has three main parts: the oxygen plant, gas preparation section and the hydrocarbon synthesis section. Auxiliary systems are used to prepare the catalyst and to convert the hydrocarbon products to gasoline. Oxygen of 95 percent purity is obtained by low temperature fractionation of air.

Synthesis feed gas, a mixture of hydrogen and carbon monoxide, is prepared by the partial combustion of natural gas with oxygen. The oxygen and gas enter the vessel separately and react at about 300 psig pressure. There are probably two main reactions. A rapid exothermic primary reaction occurs at about 3500 F when all the oxygen is consumed and water and carbon dioxide are formed. A slower endothermic secondary reaction follows with water and carbon dioxide reacting with methane to form carbon monoxide and hydrogen. The combustion zone effluent passes through a boiler section where it is partially cooled and then to a wash tower which removes traces of soot and the gases are finally cooled.

The synthesis gas is compressed to 450 psig and fed to the synthesis reactors along with recycle gas. The reactors contain a fluidized iron catalyst. The hot effluent vapor from the reactor is filtered to remove entrained catalyst fines and cooled to condense oil, chemicals, and water. The cold mixture of gas and liquids enters the base of the gas scrubber. The gas passes upward and is scrubbed with water to remove chemicals. The oil and water layers are separated in the base of the scrubber and sent to the product recovery sections. A portion of the scrubbed gas is recycled, and the net product gas is processed for additional hydrocarbon recovery.

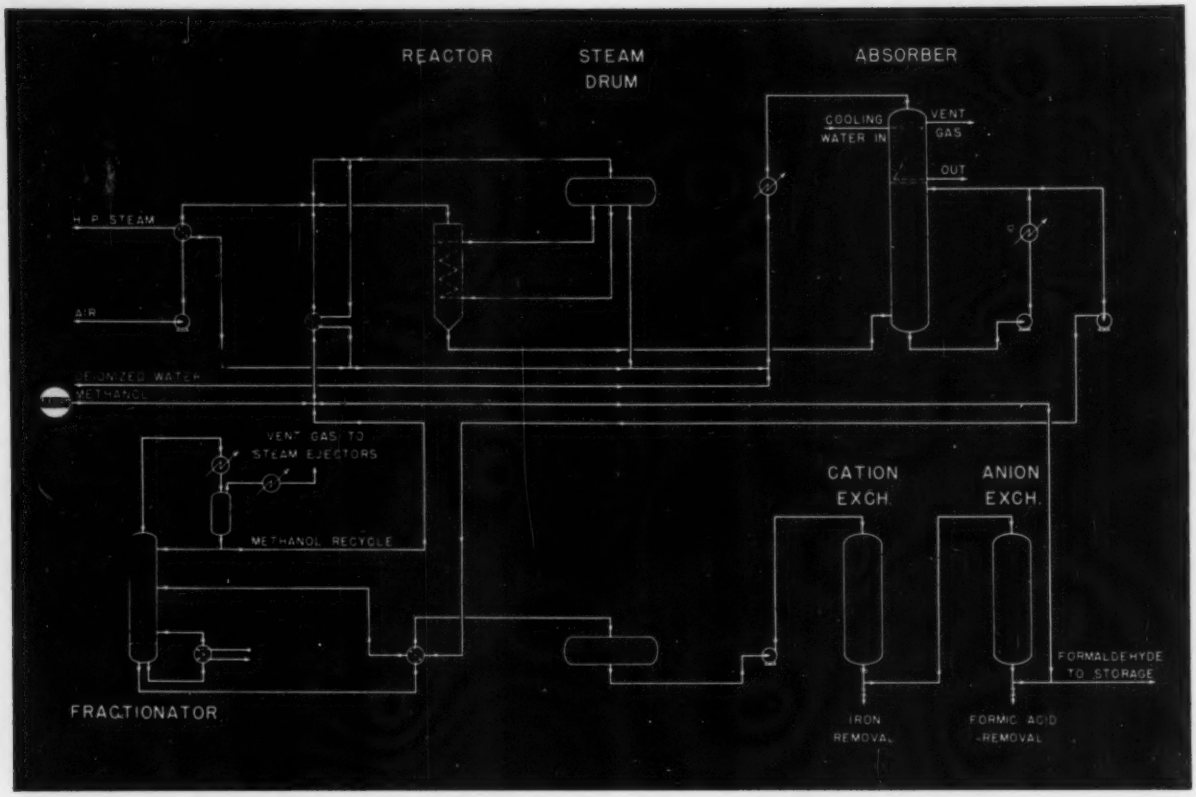
The hydrocarbon product is catalytically cracked and reformed to a good quality gasoline. The propylene and butylene hydrocarbons are polymerized to heptanes and octanes and blended with the gasoline. The water-soluble chemicals are separated and refined by separate processing.

Operating Conditions: The major operating variable in the partial combustion process is the ratio of oxygen to natural gas. The natural gas preheat, the pressure and feed rate are also fixed for a given operation. The synthesis reactor pressure is 400 psig and the average catalyst temperature is controlled over a range from 600 to 650 F. Other variables are hydrogen to carbon monoxide ratio in the fresh feed, recycle ratio and space velocity.

Yields: Based on 100 MMSCFD of natural gas with a 60 MMscfd oxygen plant a yield of 6500 bpd of gasoline and 450,000 pounds per day of chemicals is obtained.

Commercial Installations: A commercial plant of Amoco Chemicals Corporation has been operating at Brownsville, Texas, since 1956. Closed down Oct. 1 1957.

References: *Chemical Engineering Progress,* Vol. 44, No. 2, p173; *Chemical Engineering Progress,* Vol. 45, No. 8, p532; *Industrial and Engineering Chemistry,* Vol. 43, No. 12, p2782; *Industrial and Engineering Chemistry,* Vol. 45, p343, five articles.



Formaldehyde (Uhde)—ARTHUR G. McKEE & COMPANY

Application: A process for producing synthetic formaldehyde.

Charge: Anhydrous methanol.

Product: Formaldehyde solutions of 30-40 percent concentration.

Description: Anhydrous methanol vapor and air are preheated with steam before entering the catalytic formaldehyde reactor. Steam is added to the reactants to control the reaction. The mixture is passed over a silver catalyst under carefully controlled conditions to partially oxidize the methanol to formaldehyde. Temperature control in the reactor is gained by internal steam-generating coils.

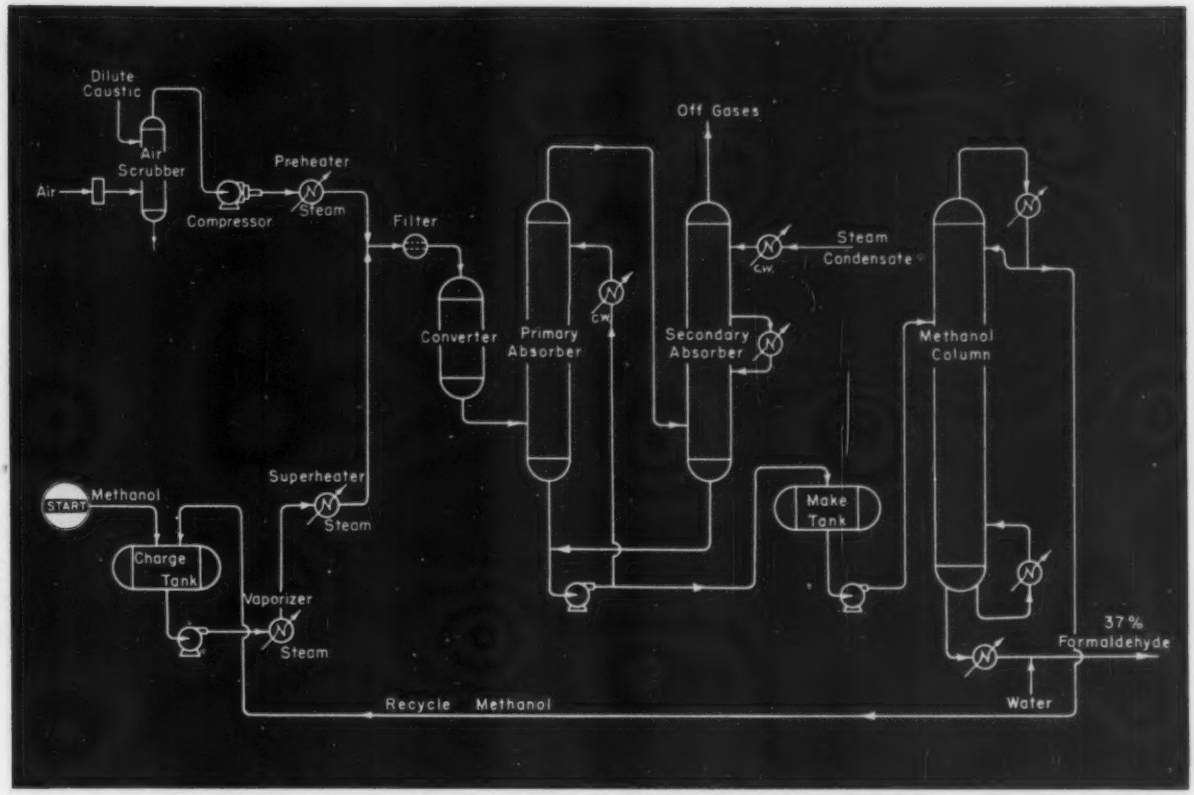
The reaction products leaving the reactor enter an absorber. This unit is fed with deionized water and contains cooling coils to remove the heat of absorption. Heat extraction by means of a recycle stream permits use of minimum amounts of water and production of concentrated formaldehyde solutions.

To suppress complete oxidation to carbon dioxide and water insufficient air is fed to the reactor to obtain max. percent conversion of methanol to formaldehyde. Therefore a fractionator is used to recover the unconverted methanol which is recycled to the reactor. The bottoms product containing the formaldehyde is passed over cationic and anionic ion exchangers to remove by-products, such as formic acid.

Following the deionization equipment the formaldehyde is taken to storage. Methanol is added as an inhibitor. Methanol requirements vary; this flow scheme allows blending to any desired methanol content.

Operating Conditions: The catalytic oxidation is carried out at pressures slightly above atmospheric. The reaction temperature is varied between 930 and 1185 F. depending upon the strength formaldehyde solutions which are desired.

Yields: The over-all yields high. When producing 37 percent formaldehyde containing 6 percent methanol yields of 88 percent are obtained.



Formaldehyde and Acetaldehyde

Application: A process for manufacturing formaldehyde from methanol or acetaldehyde from ethanol.

Charge: Methanol, 99.8 percent purity and atmospheric air for formaldehyde production. Ethanol and atmospheric air for acetaldehyde production.

Product: Either formaldehyde, 37 weight percent aqueous solution or acetaldehyde, 99 percent purity is produced, depending on the charge.

Description: *Formaldehyde.* Fresh and recycle methanol is vaporized, superheated and then passed to the methanol-air mixer. Atmospheric air is purified, compressed and then pre-heated to 130 F. in a finned exchanger.

Methanol and air are mixed in approximately equal volumetric proportions and are fed to the converter. The simultaneous reactions which occur are:

$$CH_3OH + 1/2\ O_2 \rightarrow HCHO + H_2O + 38\ \text{k-cal.}$$
$$CH_3OH \rightarrow HCHO + H_2 - 20\ \text{k-cal.}$$

The products emerge from the converter at about 1150 F. The converter is a small water-jacketed vessel which contains several layers of silver gauze catalyst. The operating pressure is 5-10 psig.

About 65 percent of the methanol is converted per pass. Oxygen conversion is essentially complete.

The reactor effluent containing about 25 percent formaldehyde is fed to two absorbers in series where cooling and separation occurs using a counter-current stream of methanol and formaldehyde. Rich solutions from both absorbers are combined and sent to the make tank.

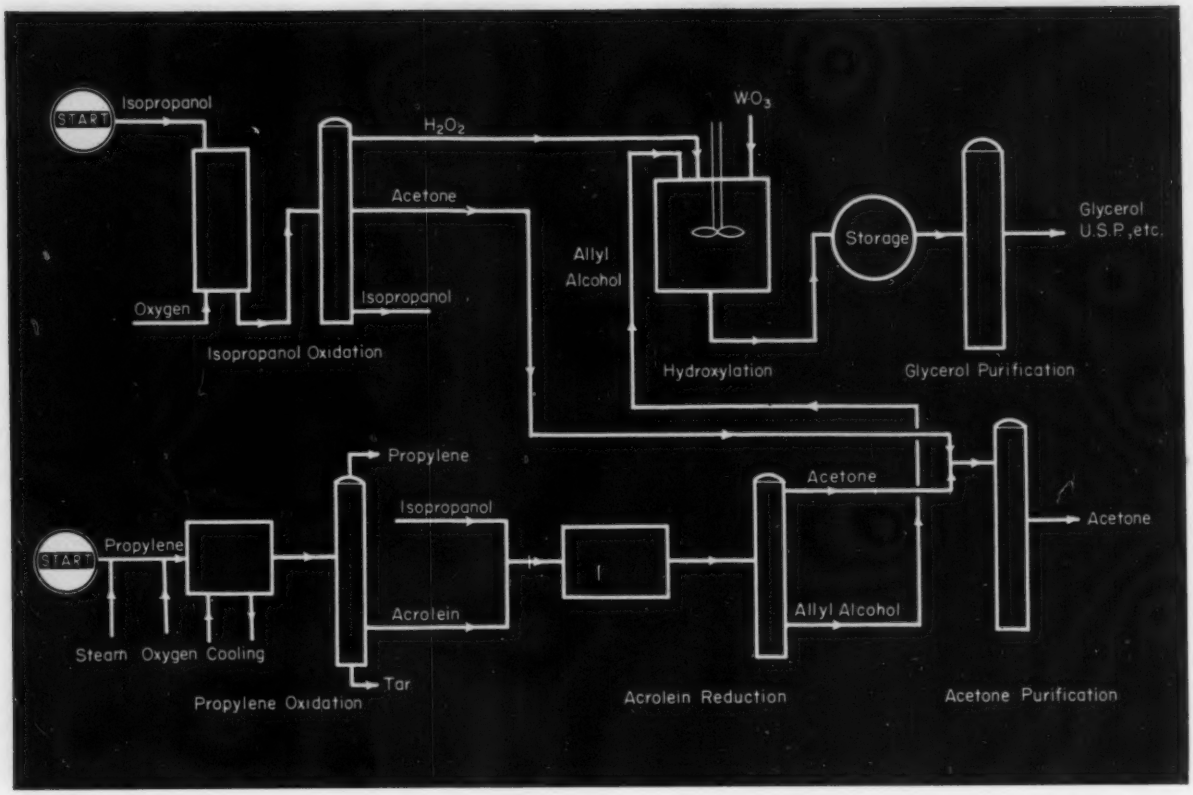
The solution is pumped from the make tank to the methanol column where 99 percent methanol is separated overhead and recycled to the charge tank. The bottom stream from this tower is the product and contains from 1-7 percent methanol. Water is added to reduce formaldehyde concentration to 37 weight percent.

Acetaldehyde. Ethanol vapor at 320 F. is mixed with air preheated to 400 F. and passed over a silver gauze catalyst. Simultaneous oxidation-dehydrogenation takes place at 1000 F. to produce acetaldehyde with a yield of 85-90 percent. Conversion per pass of ethanol is about 50 percent. The reactor effluent passes to absorption towers in which alcohol and aldehyde are cooled and condensed by a countercurrent stream of dilute alcohol. The rich liquor is rectified in a series of two columns. In the first, 99 percent acetaldehyde is removed overhead. In the second, 95 percent alcohol is removed overhead and recycled to the reactor.

Yields: Over-all process yields of formaldehyde and acetaldehyde based on charge stock, are 85-90 and 85-95 percent, respectively.

Commercial Installations: This type of process or a variation is used at the following plants: Bakelite Corporation, Bound Brook, N. J.; Commercial Solvents Corporation, Agnew, Calif.; E. I. duPont de Nemours & Company, Perth Amboy, N. J. and Toledo, Ohio; Durez Plastics and Chemicals, Inc., North Tonawanda, N. Y.; Heyden Chemical Corporation, Garfield, N. J.; Monsanto Chemical Company, Springfield, Mass.; Rohm and Haas Company, Bristol, Pa.; Spencer Chemical Corporation, Calumet City, Ill.

References: PETROLEUM REFINER, Jan.'55,p147;Feb.'55,p129; Mar.'55,p201.



Glycerol (Acrolein and Hydrogen Peroxide)

Application: This is a process for the manufacture of glycerol with large amounts of acetone as a coproduct.

Charge: Propylene, Oxygen.

Description: Propylene is first hydrated to isopropanol using a standard process. (See page 257). The isopropanol is oxidized in the liquid phase by bubbling pure oxygen through a liquid mixture of isopropanol and H_2O_2 at a pressure of about 2.5 atmospheres and at temperatures between 90 and 140 C. The reaction mixture is diluted with water, stabilized, and fractionated to yield hydrogen peroxide solution, acetone and unreacted isopropanol, which can be recycled.

A mixture of propylene with slightly more than an equal amount of steam is reacted with 25 percent oxygen based on the weight of the propylene. The reaction is carried out over a fixed bed of catalyst based on cuprous oxide, supported on SiC or some other high thermal conductivity support. Close control of reaction temperature is necessary. The reaction pressure may be from 1 to 10 atmospheres and the temperature between 300 and 400 C. The reaction mixture is cooled and fractionated to give acrolein, unreacted propylene, and tarry byproducts. The yield of acrolein is near 86 percent of the propylene consumed.

The purified acrolein is mixed with pure isopropanol from the propylene hydration step and the mixture vaporized. The mixed vapors containing 2-3 moles of alcohol per mole of acrolein are passed through a catalyst bed containing both uncalcined magnesium oxide and zinc oxide, with the magnesia predominating. The reaction takes place at about 400 C. and yields about 77 percent allyl alcohol (based on acrolein charged) and an additional quantity of acetone which is added to that formed in the isopropanol oxidation step.

Purified allyl alcohol is agitated with a water solution of hydrogen peroxide containing a small amount of tungsten trioxide in solution. The effective catalyst is a 0.2 percent pertungstic acid solution in 2 molar aqueous hydrogen peroxide. The reaction temperature is 60-70 C., reaction time is about two hours, producing glycerol in water solution.

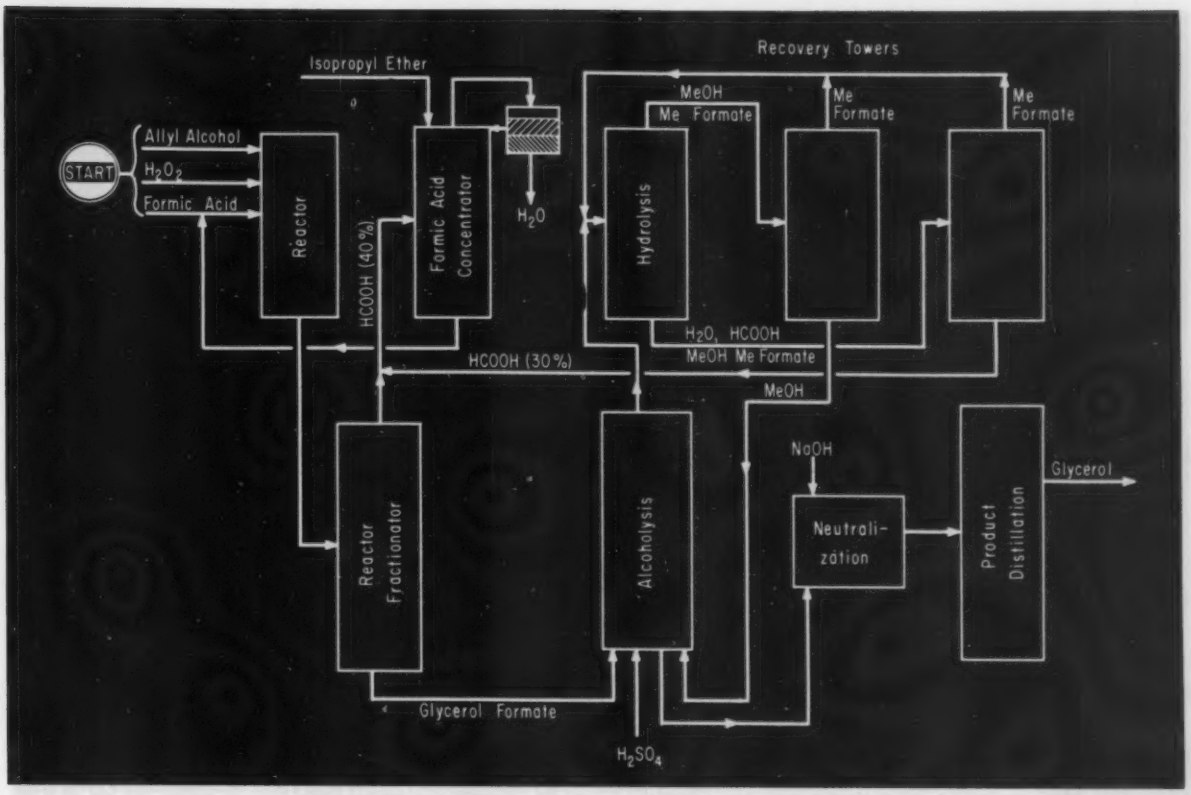
The reaction mixture is dumped to receivers and distilled to yield high-purity glycerol. The recovered catalyst solution is recycled. The yield of the final step is 80-90 percent based on the allyl alcohol charged.

Operating Conditions: The control of both the propylene oxidation step and the hydroxylation step must be exceptionally good for acceptable yields. The conditions quoted are approximate, and the practical operating limits are doubtless much less broad.

Yields: The over-all yield of useful products (glycerol and acetone) is not known. The over-all glycerol yield on propylene charged to the oxidation is in the range of 50-60 percent.

Commercial Installation: This process is used by Shell Chemical Company at Norco, La.

References: Glycerol Payoff in Propylene Parlay, *Chemical Week*, May7,'55,p72-77; S. A. Ballard, H. deV. Finch and E. A. Peterson (to N. V. Bataafsche Petroleum Maatschappij), British Patent 619,014, Mar.2,'49; M. Mugdan and D. P. Young, *J. Chem. Soc.*, 49,2988-3000,CA:43-5269h.



Glycerol (Formic Acid)

Application: This is a process for the manufacture of synthetic glycerol.

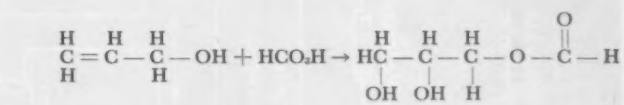
Charge: Allyl alcohol, formic acid (95 percent), methanol.

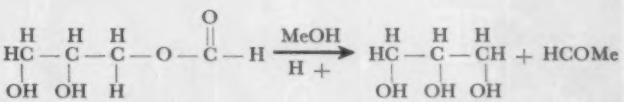
Product: Glycerol 99+ percent purity.

Description: Allyl alcohol produced from allyl chloride (see Glycerol, Epichlorohydrin) is fed to a continuous reaction chamber along with formic acid and hydrogen peroxide! Holding time in the reactor is about one hour at 46 C. The reaction mixture continuously overflows to a fractionation tower from which 50 percent formic acid is taken overhead to recovery. The bottoms from his tower pass to the alcoholysis reaction. Methanol is added and reacts, in the presence of a small amount of H_2SO_4, to produce methyl formate which vaporizes under the conditions of the reaction, leaving crude glycerol as a residue. The crude product is neutralized with caustic, washed, and distilled to produce a 99+ percent purity product for sale.

In the recovery system, methyl formate is hydrolyzed with acid catalyst, producing a hydrolysis product containing methanol, formic acid, water, and unhydrolized methyl formate. This mixture is distilled to recover dilute formic acid, concentrated methanol, and recycle methyl formate. The dilute formic acid is concentrated by azeotropic distillation with isopropyl ether and recycled to the beginning of the process.

The reactions involved in this process are hydroxylation, ester interchange, and hydrolysis. The most probable effective reactant in the first reaction is performic acid, leading to the following series of reactions:



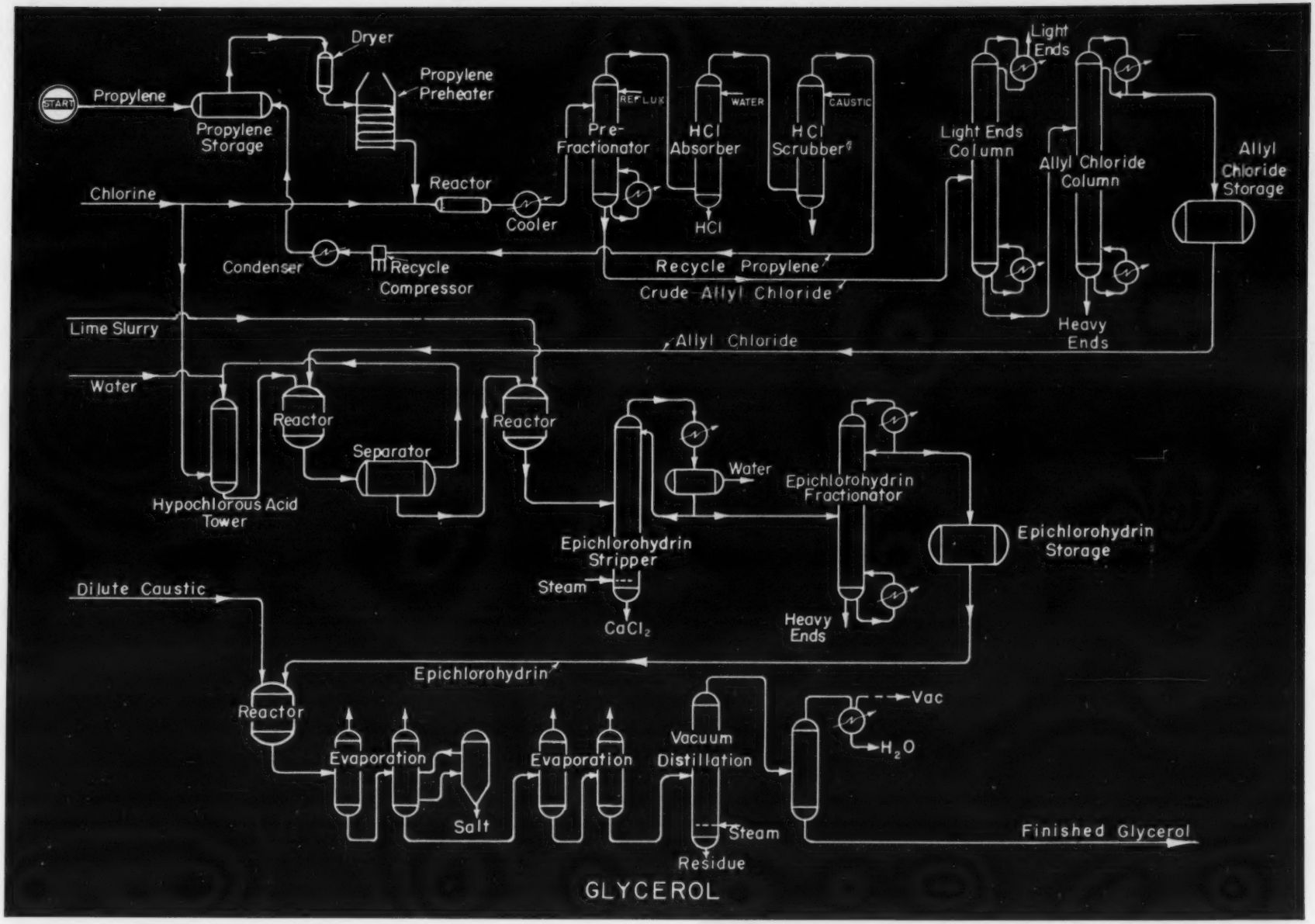


Operating Conditions: The hydroxylation is run near 50 C., and the maximum temperature in the reaction mixture fractionator is limited to 150 C. The methanolysis reaction operates at 105 C. with 2 percent of 66° Be. sulfuric acid as catalyst.

Yield: The yield of glycerol is 94 percent based on allyl chloride.

Commercial Installations: A plant is planned for the Orange, Texas area.

Reference: Albert E. Corey and J. N. Crosby (to Allied Chemical and Dye Corp.) U. S. 2,739,173 (Mar. 20, 1956).


START
Propylene
Propylene Storage
Dryer
Propylene Preheater
Chlorine
Reactor
Cooler
Pre-Fractionator
REFLUX
HCl Absorber
WATER
HCl
HCl Scrubber
CAUSTIC
Light Ends
Light Ends Column
Allyl Chloride Column
Allyl Chloride Storage
Heavy Ends
Condenser
Recycle Compressor
Recycle Propylene
Crude Allyl Chloride
Lime Slurry
Allyl Chloride
Water
Reactor
Separator
Reactor
Hypochlorous Acid Tower
Water
Epichlorohydrin Fractionator
Epichlorohydrin Stripper
Steam
$CaCl_2$
Epichlorohydrin Storage
Heavy Ends
Dilute Caustic
Epichlorohydrin
Reactor
Evaporation
Salt
Evaporation
Vacuum Distillation
Vac
H_2O
Steam
Residue
Finished Glycerol
GLYCEROL

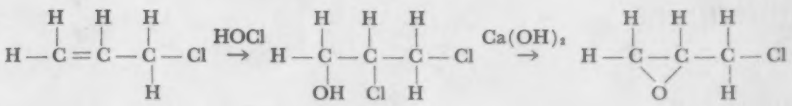
Glycerol (Epichlorohydrin)

Application: This process is for the manufacture of synthetic glycerol.

Charge: Propylene, 98 percent purity and chlorine 99+ percent purity are the charge.

Product: Glycerol (glycerine), 99+ percent purity, is the product.

Epichlorohydrin is produced from allyl chloride by the following reactions:



Description: For convenience, the synthetic glycerol process may be divided into three successive operations, the end products of which are allyl chloride, epichlorohydrin, and finished glycerol (termed "glycerine" in commercial practice). A portion of the allyl chloride produced is used in the manufacture of allyl alcohol. Similarly, a portion of the epichlorohydrin produced is used in the manufacture of epoxy resins. Although synthetic glycerol production accounts for a small portion of the nation's total, it serves the very important function of buffering the otherwise-fluctuating price of glycerol.

Allyl chloride is produced by the hot chlorination of propylene. Substitution rather than addition of chlorine takes place. This is the most important step in the synthesis and the one which presented most difficulties in the original development.

Fresh liquid propylene is fed to a storage tank where it is blended with recycle propylene in a ratio of about 1:3. The blend is dried over a solid desiccant, preheated to 650-700 F. in a fired tubular heater, and mixed rapidly with cold chlorine gas. The reactor is a simple steel tube which is operated adiabatically. The reaction is exothermic and the products leave at 950 F. The ratio of propylene to chlorine in the feed is 4:1. Conversions of propylene and chlorine are about 25 percent and 100 percent, respectively. The yield of allyl chloride is 80-85 percent. The operating pressure is 15 psig. A certain amount of coking occurs and a multiple-unit arrangement allows periodic de-coking without disturbance of operating continuity.

The effluent gases are cooled quickly to 120 F. in a tubular exchanger and are sent to the prefractionator. Unconverted propylene plus hydrogen chloride are removed overhead. Reflux is dry liquid propylene at —40F. The overhead gas is scrubbed first with water and then with caustic before being compressed, liquefied, and returned to charge propylene storage. A by-product stream of 32 weight-percent HCl is recovered from the water-scrubbing operation.

The bottoms stream from the prefractionator contains about 75 weight percent allyl chloride. Dichloropropane is the major contaminant. Purification is effected in two conventional fractionators. The first serves to remove the 1-2 percent light ends present in the crude allyl chloride and the second serves to remove dichloropropane and other high boilers. The purified allyl chloride is placed in storage for use in the manufacture of allyl alcohol and glycerol.

Chlorine and water are reacted in a tower to form a solution of hypochlorous acid which is in turn reacted with allyl chloride in a stirred tank to form a mixture of dichlorohydrins. The desired reaction takes place in the aqueous phase, and a minimum of allyl chloride is allowed in the reaction zone in order to avoid side reactions in the non-aqueous (allyl chloride) phase. The reaction is exothermic but readily maintained in the 85-100 F. range by the excess of acid.

The reactor effluent passes to a separator tank where the aqueous phase is removed and recirculated to the chlorinating tower. The non-aqueous phase, containing the mixture of dichlorohydrins, is fed to a stirred reactor where it is contacted with a lime slurry. The reactor contents are maintained below 140 F. Essentially complete conversion to epichlorohydrin is obtained. The product is steam-distilled at atmospheric pressure as a water azeotrope which contains in addition a small amount of unreacted dichlorohydrin. Epichlorohydrin of 98 percent purity is obtained from a final distillation.

Glycerol is formed by the hydrolysis of epichlorohydrin, using sodium hydroxide. Dilute (about 10 percent) caustic is added to the epichlorohydrin in a stirred tank. Essentially complete conversion to glycerol is obtained. The effluent from the tank is a dilute solution of glycerol containing sodium chloride. Salt and most of the water are removed in a multiple-effect evaporation system. At an intermediate point the salt crystallizes and is removed from the bottom of the evaporator. A certain amount of glycerol is recovered from the ensuing settling operation and is recycled to the evaporation system. Reduced pressure is used in the latter stages of the evaporation. Crude glycerol of about 90 percent purity is obtained.

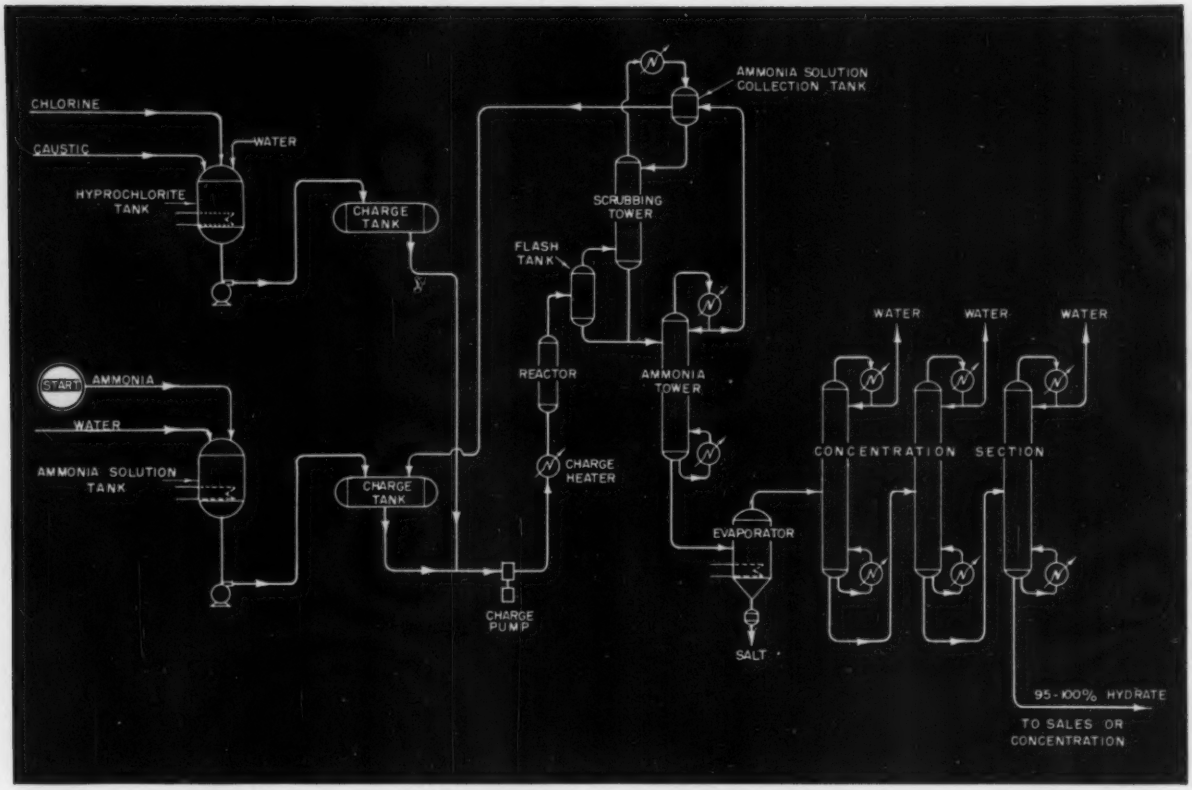
Glycerol of 99+ percent purity is obtained in a final vacuum distillation operation. It is stored in nickel-clad steel tanks and shipped from the plant in aluminum tank cars.

Operating Conditions: The key reaction in the glycerol synthesis is the hot chlorination of propylene. Typical operating conditions for this reaction are given in the above text.

Yields: Over-all process yield, glycerol from propylene and chlorine is 75-80 percent.

Commercial Installation: This process or a variation is used at Shell Chemical Company at Deer Park, Texas, Norco, La., and The Dow Chemical Company, Freeport, Texas.

References: Miner, C. S. and N. N. Dalton (Eds) Glycerol, *ACS Monograph*, No. 117, '54,pp80-83; *Chemical Engineering*, 55, No. 10, Oct. '48,pp134-137.



Hydrazine

Application: A process for the manufacture of hydrazine.

Charge: Dilute caustic soda (8 percent); chlorine; ammonia.

Product: Hydrazine (N_2H_4); hydrazine hydrate ($N_2H_4 \cdot H_2O$) of 95-100 percent strength.

Description: Chlorine and dilute caustic are mixed to produce an aqueous sodium hypochlorite (NaOCl) solution. About ten percent excess caustic is used. For 8 percent caustic the resulting hypochlorite strength is about 70 grams per liter available chlorine.

Anhydrous ammonia is dissolved in purified water to form a 28 weight-percent solution. This material is mixed with a recycle solution of the same strength and placed in a charge tank to be fed to process.

Ammonia and hypochlorite solutions are combined in a molar ratio considerably greater than the 2:1 stoichiometric requirement. Ratios as high as 20-50 NH_3:NaOCl have been used. The mixture is pumped to a pressure of 30 atmospheres, preheated to 320 F., charged, and passed quickly through the tubular reactor.

The successive reactions which occur are:

$$NaOCl + NH_3 \rightarrow NH_2Cl + NaOH$$
$$NH_2Cl + NH_3 \rightarrow H_2N \cdot NH_2 + HCl$$

Conversion of hypochlorite is practically complete. It is necessary to use carefully purified water in the mixing and adjustment of concentration of the reactant solutions, and at the same time employ a purified gelatin inhibitor. With sufficient amounts of this inhibitor the hydrazine yields across the reactor are in the range of 80-90 percent.

The effluent from the reactor contains about 1.5 percent hydrazine in an aqueous solution together with NaCl, NaOH, unconverted ammonia, and minor amounts of side reaction products. The liquid is flashed to a pressure slightly above atmospheric with resulting liberation of ammonia and small amounts of hydrazine. The liquid from the flash chamber is combined with the bottoms stream from the scrubbing tower and fed to an ammonia tower for further ammonia recovery.

The bottoms from the ammonia tower contain the major impurities NaCl (5-6 percent) and NaOH (minor amount). The concentration of hydrazine hydrate ($N_2H_4 \cdot H_2O$) is about three percent. NaCl and NaOH are removed by salting-out in an evaporator. The vapors from the evaporator contain 6-8 percent hydrazine hydrate.

Further concentration of the hydrate is effected in a series of three distillation columns. The concentration becomes in turn 15 percent, 40-45 percent, and 95-100 percent hydrate. The final tower, which produces concentrated hydrate bottoms material, is kept under a nitrogen blanket to minimize explosion dangers.

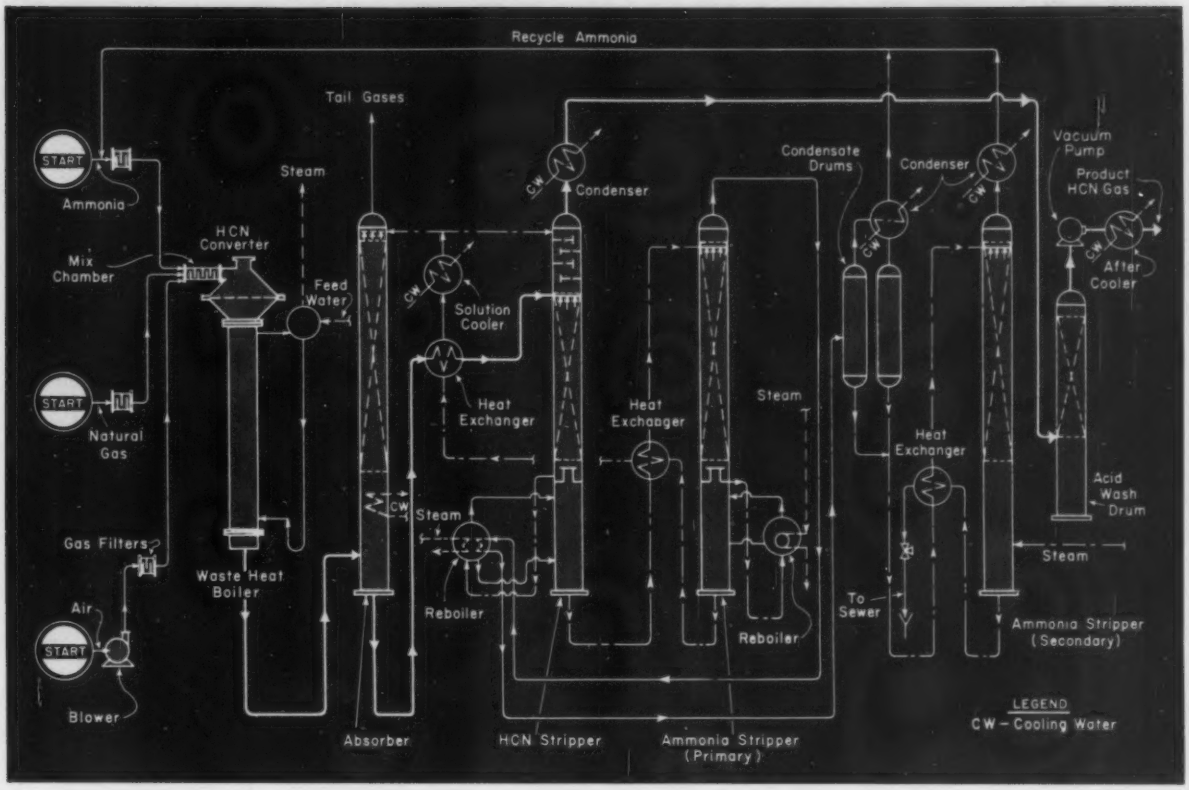
It is not possible to produce anhydrous hydrazine by simple distillation since water and hydrazine form an azeotrope at 58.5 mole percent hydrazine.

Operating Conditions: Given in above text.

Yields: Over-all process yields of 70-75 percent are obtained, based on available chlorine raw material.

Commercial Installations: Mathieson Chemical Corporation at Lake Charles, La.; Fairmont Chemical Company, Newark, N. J.

Reference: Petroleum Refiner, Dec.'54,p166.



Hydrogen Cyanide—THE GIRDLER COMPANY

Application: A process applied to the manufacture of hydrogen cyanide. The reactor gas may also be used directly to produce various cyanides by absorbing hydrogen cyanide in appropriate solutions.

Charge: Natural gas and anhydrous ammonia are the charge.

Product: The product is gaseous hydrogen cyanide of 99 percent purity.

Description: Hydrogen cyanide is produced by the reaction of ammonia, natural gas and air over a platinum catalyst which may be represented as follows:

$$NH_3 + CH_4 + 1.5\ O_2 \rightarrow HCN + 3H_2O$$

A unique process developed by Freeport Sulphur Company is employed to separate the hydrogen cyanide from the side reaction gases and to allow the separate recovery of unreacted ammonia.

Ammonia and natural gas, under at least 5 to 10 psig pressure, are filtered and mixed prior to entering the converter vessel. The converter operates at 1800 F. and pressures slightly above atmospheric. The composition of the effluent gas is given below:

Composition of Gas Produced in Generator

	Mole Percent
Hydrogen Cyanide	5.9
Ammonia	1.6
Carbon Dioxide	0.2
Carbon Monoxide	4.4
Methane	0.5
Hydrogen	7.5
Oxygen	0.1
Nitrogen	56.7
Water Vapor	23.1
	100.0

The effluent gases are cooled immediately.

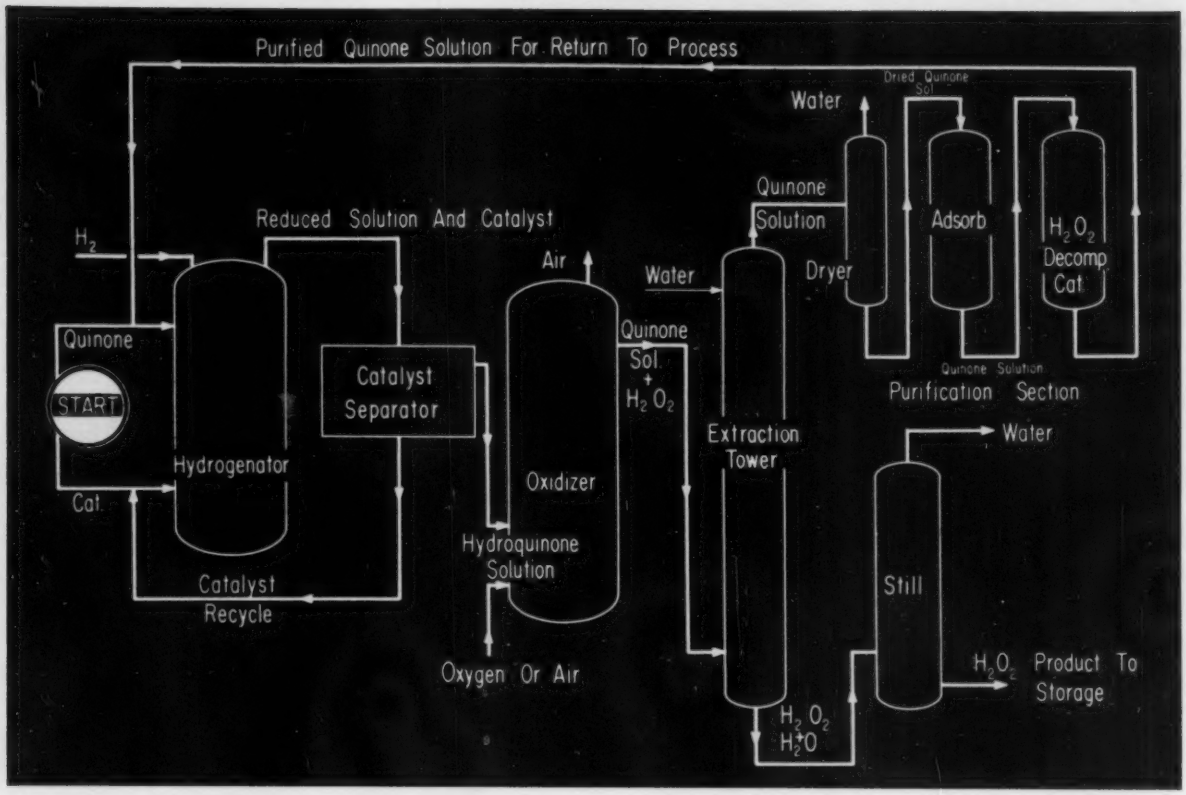
Of the ammonia fed to the converter approximately 60 percent is converted to hydrogen cyanide, 20 percent is dissociated to hydrogen and nitrogen and 20 percent passes through unreacted. As the majority of unreacted ammonia may be recovered and recycled, the over-all ammonia conversion to HCN is about 75 percent.

The separation system is based on the use of a polyhydroxy-boric acid complex. A solution of 8.3 weight percent pentaerythritol and 2.5 weight percent boric acid in water is used. This complex reacts with ammonia in the absorber which prevents polymerization of HCN. The HCN is absorbed by water. HCN is stripped from the absorber bottom stream in the HCN stripper. Residual ammonia is removed from the HCN stream by washing with fresh solvent. The product is then acid washed for final cleanup and delivered at atmospheric pressure. The HCN-free solution goes to the primary ammonia stripper where the polyhydroxy-boric acid complex dissociates and releases ammonia. The stripper operates at 25 psig pressure and 270 F. Some ammonia gas is liberated here, cooled and recycled to the HCN converter. The condensate from this gas stream is steam stripped in the secondary ammonia stripper where the bulk of the ammonia is recovered and recycled.

Yields: Approximately 75 percent of ammonia charged is converted to hydrogen cyanide.

Commercial Installations: The complete process has been developed through the pilot plant stage by Freeport Sulphur Company. A commercial plant producing reactor gases only is in operation at Imperial Paper & Color Corp., Glens Falls, N. Y.

Reference: PETROLEUM REFINER, Vol.32,No.9,Sept.(1953)p196
The Girdler Co. is a division of National Cylinder Gas Co.



Hydrogen Peroxide—BECCO CHEMICAL DIVISION OF FOOD MACHINERY & CHEMICAL CORP.

Application: A non-electrolytic process for manufacturing hydrogen peroxide.

Charge: An alkylated anthraquinone, quinone and hydroquinone solvents, catalyst, hydrogen, air or oxygen, water.

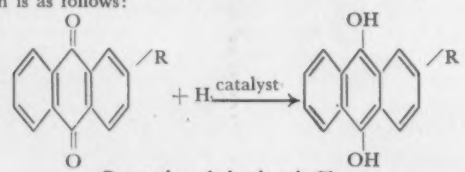
Product: Aqueous hydrogen peroxide of 15 percent-35 percent concentration by weight.

Description: The process consists of reducing anthraquinone to hydroquinone, oxidation back to quinone with hydrogen peroxide production, extraction of hydrogen peroxide, and purification of process solution for recycle.

The alkylated anthraquinone, usually 2-ethyl or 2-tertiary butyl anthraquinone, is obtained from Friedel-Crafts reaction of phthalic anhydride and ethyl (or tertiary butyl) benzene.

The working solution (anthraquinone in solvent) is fed to the hydrogenator and reduced to the hydroquinone stage with hydrogen and catalyst. Solvents may be—aromatic hydrocarbons, alcohols, ketones, esters, etc.—which maintain the quinone and hydroquinone in solution.

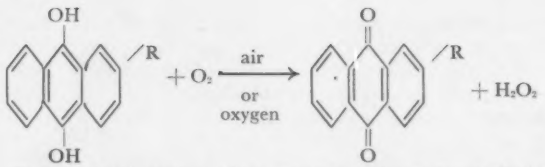
Hydrogenation is at room temperature to 40 C. or more and hydrogen pressure of 1-3 atmospheres. Catalysts may be Raney nickel, nickel, palladium or platinum. Hydrogenation is less than theoretical to avoid hydroquinone precipitation and the formation of nuclear hydrogenated products. The main hydrogenation reaction is as follows:



R may be ethyl, t-butyl, Cl, etc.

Catalyst is removed from the hydrogenated solution by filtration or centrifugation and recycled. Catalysts used also decompose hydrogen peroxide and reduce yields in the oxidation step.

The hydroquinone solution then passes through a series of air or oxygen oxidizers. The hydroquinone is reconverted to quinone and hydrogen peroxide formed, as shown below:



The oxidized solution (½-1 percent hydrogen peroxide) is extracted, the hydrogen peroxide-rich organic solution rising countercurrent to the top entering water. The solvents used must yield operable density gradients and partition coefficients for hydrogen peroxide between aqueous and organic phases. Density gradients are 0.05-0.1 g/cm³. The extractors operate at 25-40 C. and yield 15-35 weight percent hydrogen peroxide. This solution goes to storage or to vacuum stills for concentration to any desired strength.

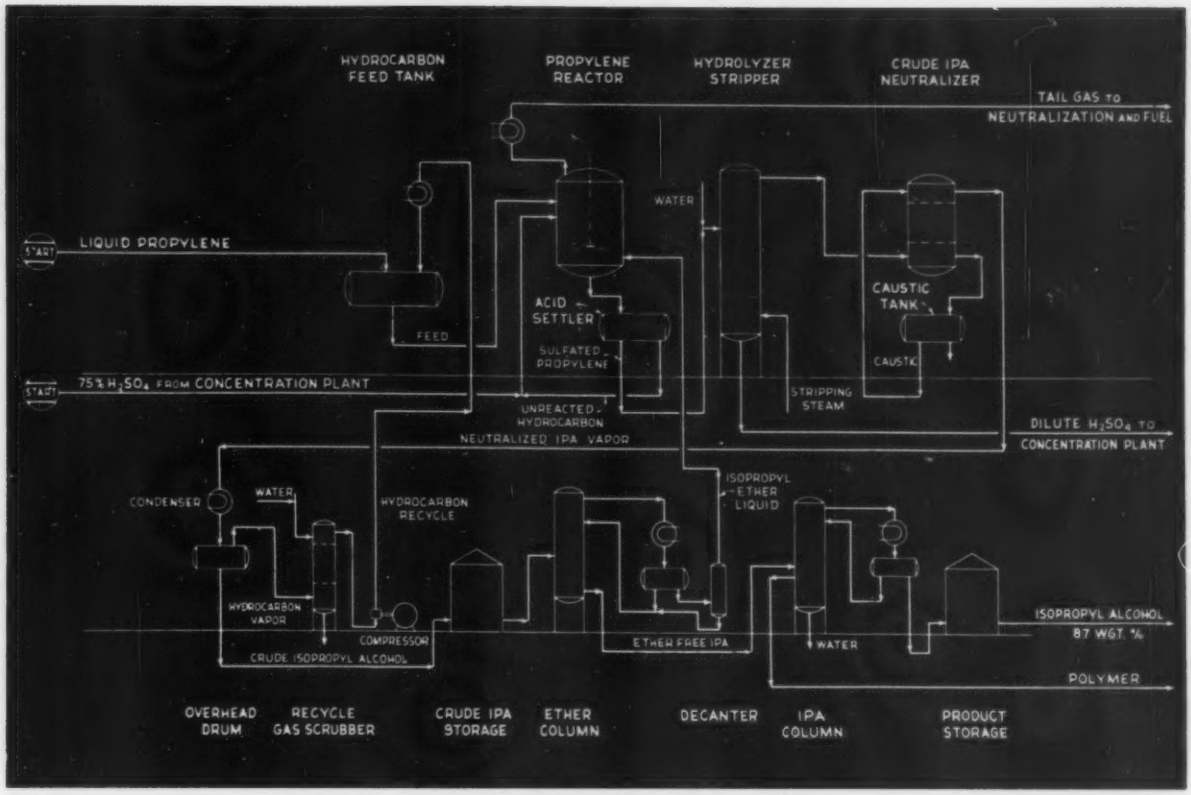
The organic phase, leaving the final extractor, is separated from entrained water and partially dried. Traces of hydrogen peroxide, if harmful to the catalyst, are removed by catalytic treatment before the work solution is recycled. A typical cycle requires 2-4 hours. A plant producing 100 lbs./hour of hydrogen perxoide (100% basis) may require 20,000-50,000 lbs. of work solution.

Operating Conditions: The principal operating conditions given above are influenced by the solvent, catalyst, etc.

Yields: The yield of hydrogen peroxide has been reported as 90 percent of the theoretical, based on hydrogen consumption.

Commercial Installations: This process, or a variation thereof, is reputedly used in plants operated or being built by the following chemical companies in the U. S.: Becco Chemical Division, Food Machinery and Chemical Corp., Buffalo, N. Y.; Columbia-Southern Chemical Corp., Barberton, Ohio; E. I. duPont de Nemours & Company, Memphis, Tenn.; and Solvay Process Division, Allied Chemical & Dye Corp., Syracuse, N. Y.

References: Kirk-Othmer, "Encyclopedia of Chemical Technology," Vol. 7, Article on "Hydrogen Peroxide." The Interscience Encyclopedia, Inc., New York (1951). *Chemical Week*, p75, No.5,1955.



Isopropyl Alcohol—STONE & WEBSTER ENGINEERING CORPORATION

Application: A process for manufacturing isopropyl alcohol.

Charge: Liquid propylene. A feed of 90 percent purity or better is desirable to minimize the handling of waste gas, although much lower concentrations of propylene can be handled satisfactorily.

Product: The product is a solution of 87 weight percent isopropyl alcohol. This product can be concentrated to 99 weight percent alcohol by adding one more fractionating step.

Description: The liquid propylene feed stock, combined with recycled hydrocarbons, is first absorbed in 75 percent sulfuric acid in a series of agitated reactors to form a solution of diisopropyl sulfate and isopropyl acid sulfate. The sulfated hydrocarbon solution is converted to an acid solution of isopropyl alcohol, ether and polymer by hydrolysis reactions which take place in the hydrolyzer-stripper in the presence of dilution water. These reaction products are stream stripped from the acid in the same column and leave as overhead vapors. The vapors are neutralized by contact with caustic solution and then condensed.

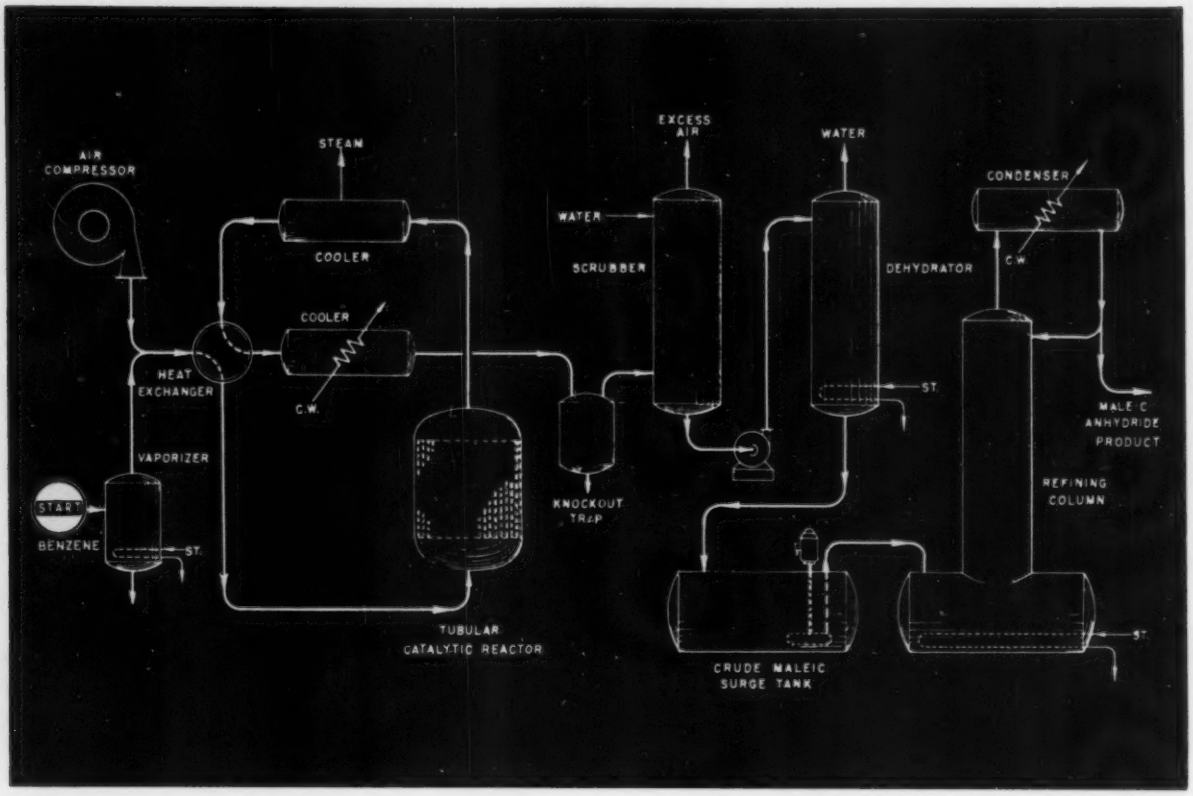
The crude isopropyl alcohol is charged to the ether column. The bulk of overhead vapors from this column is condensed and refluxed to the column. A portion of the liquid is diverted from the main reflux stream and sent to a decanter for separation. In the decanter the two liquid layers are separated; the upper layer is very rich in ether, and the lower layer contains mainly water and small amounts of ether and alcohol. The lower water-rich layer is refluxed back to the tower continuously along with the main reflux stream going to the column. The ether-rich layer is pumped back into the reaction system.

The liquid containing the bulk of the isopropyl alcohol, polymer and water, is pumped to the isopropyl alcohol column for recovery of the main product. The condensed overhead from this column is the 87 percent solution of isopropyl alcohol in water. Polymer is withdrawn as a side stream from the column and pumped to storage. From the base of the isopropyl alcohol column, water is withdrawn containing only traces of alcohol. This water is reused in the hydrolyzer-stripper.

Operating Conditions: The propylene sulfation occurs in the reactors at 300-400 psig. All other equipment, except for the propylene feed tank, operates at near atmospheric pressures. No mechanical refrigeration is required.

Yields: Ninety-five percent of propylene charge is converted to isopropyl alcohol.

Commercial Installations: This process is based on development work carried out by the Distillers Company, Ltd., with recent improvements by Stone and Webster. Commercial plants using this process are operating in the United Kingdom and Japan.



Maleic Anhydride—SCIENTIFIC DESIGN COMPANY, INC.

Application: A process for the manufacture of maleic anhydride.

Charge: Benzene, nitration grade.

Product: Maleic anhydride, pellets.

Description: Benzene is vaporized in kettles and fed to a vessel for mixing with air. The mixed gases are preheated and passed to a multitubular, cooled catalytic reactor.

The reactor effluent gases pass through three coolers in sequence. The first cooler generates steam. The second is a recuperative exchanger which serves to preheat feed gas. The third cooler uses cooling water. Tarry condensates are removed by a knockout trap. The reactor effluent gases then pass to a water scrubber where maleic anhydride is absorbed. The maleic acid solution is pumped to a dehydrator which regenerates maleic anhydride. Only a minimum of maleic is transformed to isomeric fumaric acid in the dehydration step, by careful control of conditions. The crude maleic anhydride is purified in a refining column. The product cut is pelletized and bagged in conventional machines.

Tempered cooling water is used to prevent plugging of the reactor aftercooler by solid maleic anhydride. A startup heater (not shown on this schematic flow diagram) serves to bring the feed airstream up to reaction temperature. This preheater burns natural gas or other cheap fuel.

Several oxidations take place simultaneously in the reactor; the two most important reactions are represented as follows:

(1) $C_6H_6 + 4\frac{1}{2}O_2 \rightarrow C_4H_2O_3 + 2\,H_2O + 2\,CO_2$

(2) $C_6H_6 + 7\frac{1}{2}O_2 \rightarrow 6\,CO_2 + 3\,H_2O$

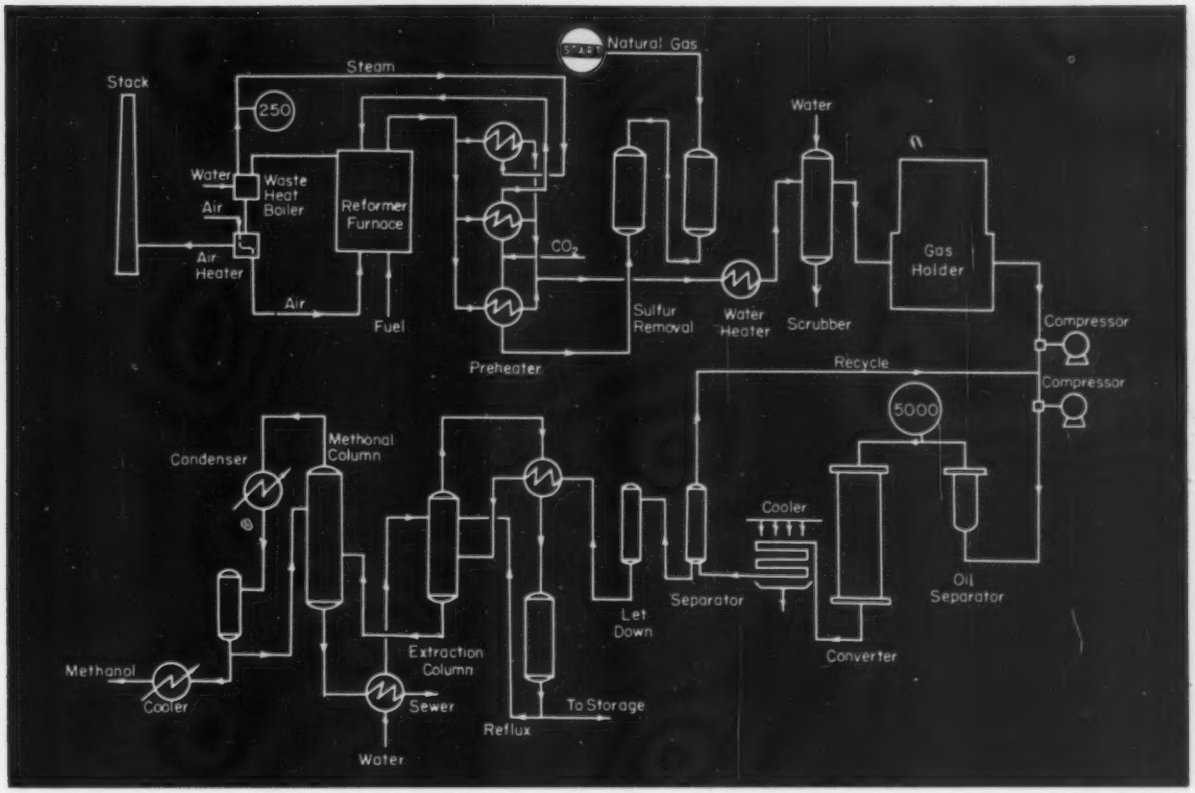
Operating Conditions: The most important operating variables are the benzene concentration in the reactor inlet gases, the temperature in the reactor, and the contact time. Typical operating ranges for these variables are given below:

Benzene concentration: 0.6-1.6 percent by volume
Reaction temperature: 700-850 F.
Contact time: 0.1-2.0 seconds

Yields: The over-all yield is usually expressed as pounds of maleic anhydride per pound of benzene. Yields of over 70 percent have been obtained, and yields approaching 80 percent are expected in future installations.

Commercial Installations: Compagnie Francaise des Matieres Colorantes, Villers-St. Paul, France. A reaction system using the Scientific Design Company catalyst has been in commercial operation at Reichhold Chemicals' Elizabeth, N. J., plant for several years.

Reference: *Chemical Engineering,* July'53,p238.



Methanol—COMMERCIAL SOLVENTS CORPORATION

Application: A process for the manufacture of methanol.

Charge: Natural gas.

Product: Methanol.

Description: The first step in the process is the removal of organic sulfur and hydrogen sulfide from the natural gas feed stock. This is accomplished in the sulfur removal vessels by contacting the gas with activated carbon.

The purified gas is pre-heated by exchange with reformer products, mixed with carbon dioxide and superheated steam and passed downward in the reformers. The reformers are heated with fuel gas and the flue gas is used to generate 250 psi steam and to heat the primary combustion air for the reformer heater burners. The reformer product stream is further cooled in the feed water heater and then water quenched before going to a gas holder.

The cooled reformed gas from the gas holder is compressed to 5000 psig by the primary compressors and the circulating compressors. This high pressure gas stream flows to oil traps for the removal of entrained oil before being introduced to the converters. The outlet from the oil trap vessel and filter is divided into three (3) streams. The main stream goes to the converter top and a small by-pass stream sent to the bottom of the converter for quench while a small stream is sent to the quench lines at the top of the reactor. The converter effluent is cooled in a spray cooler and flows to a separator. The unconverted gases from the separator are recycled to an intermediate stage of the primary compressors and the condensed product from the separator flows to the low-pressure letdown and separator drum. The liquid product from the letdown drum flows to crude methanol storage.

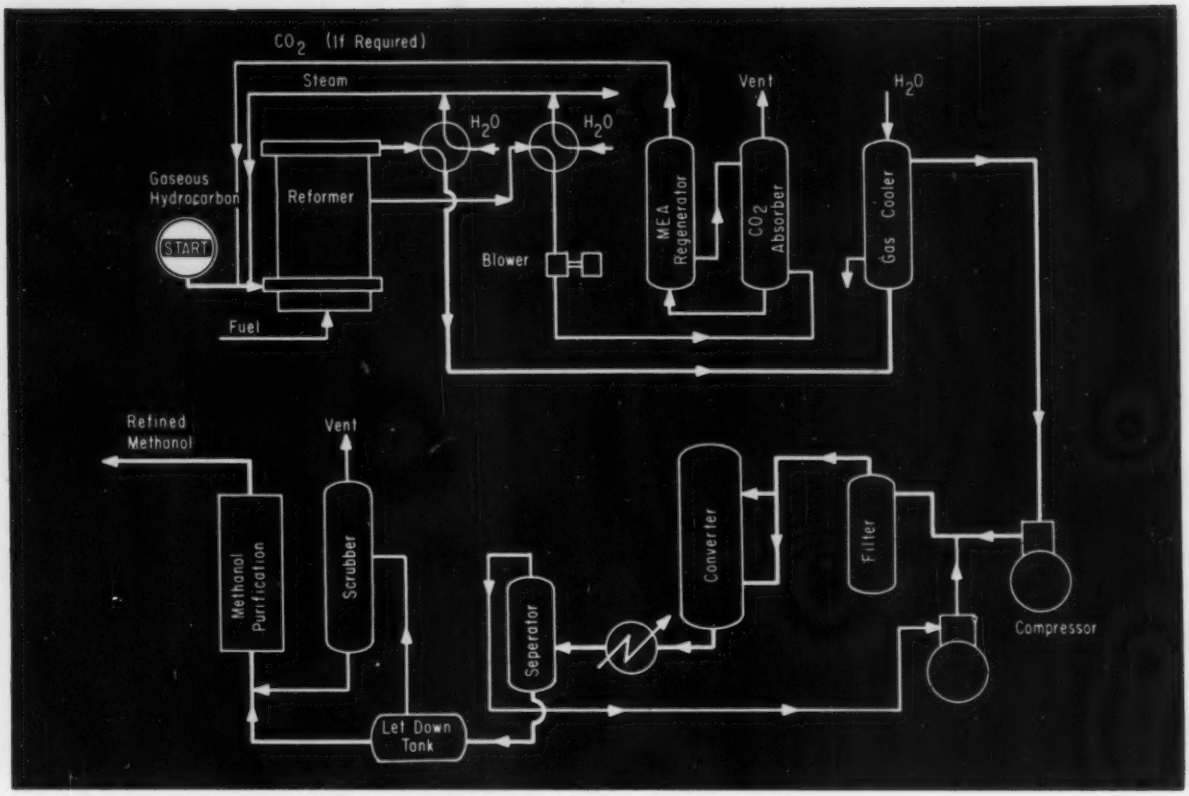
The impurities present in the crude methanol (isopropyl and isobutyl alcohol, traces of ethers, ketones and aldehydes) have boiling points near that of methanol itself and present a real problem in the purification of methanol. The extractive distillation method is used by Commercial Solvents Corporation.

The crude methanol is preheated in the extraction column condensers and fed to the extraction column. The heads from this column are partially used for reflux and the remainder cooled and sent to intermediate storage. Soft water, heated by exchange with the methanol column bottoms, is introduced as extract in the extraction column. The bottoms from the extraction column are fed to the methanol column where the overhead is finished methanol product. A portion of this overhead is used for reflux on the methanol column. The bottoms are sent to sewer. A bottom fraction is removed from the methanol column and goes to the tails column for the recovery of higher alcohols.

Operating Conditions: The converter operates at 5000 psig and 400 C. with about 12 to 15 percent conversion of feed gas to methanol per pass.

Commercial Installation: Commercial Solvents Corporation, Sterlington, La.

Reference: *Chemical Engineering*, June '55.



Methanol—CHEMICAL CONSTRUCTION CORPORATION

Application: This is a process for the manufacture of methanol.

Charge: The feed to the process may be any mixture of gaseous hydrocarbons below hexane consisting primarily of saturates, or acetylene off-gas, or a mixture of hydrocarbons and off-gas.

Description: Hydrocarbons are reformed to hydrogen, carbon monoxide and carbon dioxide by reaction with steam at about 30 psig.

Methanol requires slightly different reformer operating conditions than those for the production of ammonia synthesis gas. A somewhat lower reformer pressure is used and there is no secondary reforming step. No carbon monoxide shift converter is required for methanol production.

Some feed gases require that carbon dioxide be added to the gas stream before reforming. In this case the required quantity of carbon dioxide is recovered from the flue gas from the reforming furnace by scrubbing with MEA solution, if carbon dioxide is not available from another source.

The reformed gas is cooled in a waste heat boiler and then by direct contact with water. It is then compressed to 5200 psig at which pressure it is synthesized to methanol as illustrated.

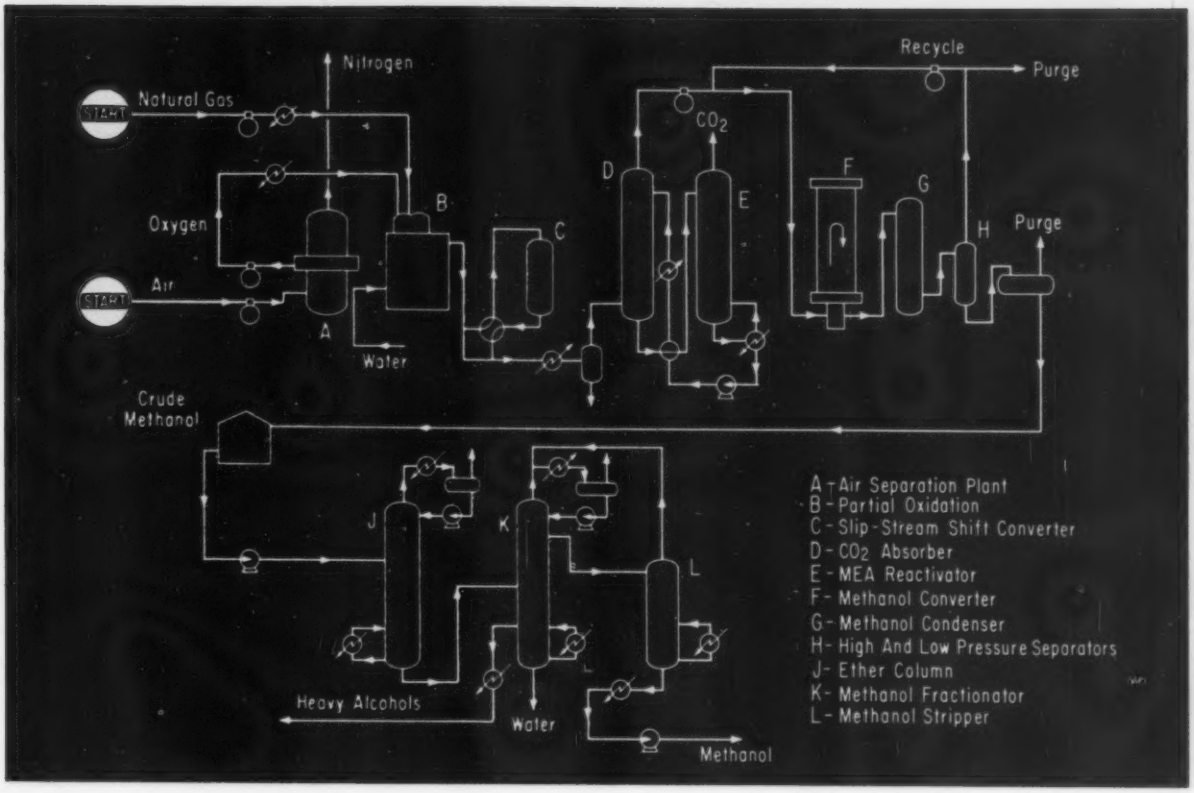
The methanol is almost completely condensed in a water cooled exchanger and then passes into the separator. Gases dissolved in the raw product methanol at 5000 psig flash from the liquid when the pressure is reduced in the let-down tank. Methanol in the fiashed gas is recovered and mixed with the raw product.

The raw product is then refined by distillation.

Products: The refined product methanol has a purity of 99.85 percent.

Operating Conditions: Important operating conditions are given in the preceding description.

Commercial Installations: There are several domestic and foreign installations in operation or under construction.



Methanol—FOSTER WHEELER CORPORATION

Application: A process for the manufacture of methanol.

Charge: Natural gas and air.

Product: Methanol.

Description: The methanol synthesis process described in the flow diagram represents the combined development efforts of Casale and Foster Wheeler. It is based on the catalytic union at high pressure of hydrogen and carbon monoxide following the formula: $CO + 2H_2 \rightarrow CH_3OH$.

Filtered air, compressed to approximately 85 psig, enters the air separation plant where it is separated into oxygen and nitrogen. The nitrogen may be utilized in a separate ammonia synthesis plant; otherwise, it is vented to the atmosphere. Oxygen of 98 percent purity is compressed to approximately 425 psig and delivered to the synthesis gas generation section (Texaco partial oxidation).

Natural gas is compressed, preheated and joins the oxygen in the Texaco generator. The partial oxidation reaction produces a crude synthesis gas consisting principally of hydrogen and carbon monoxide. The bulk of this gas is cooled and flows to the purification section. A slip stream passes through a shift converter where catalytically, some of the carbon monoxide reacts with water vapor to form additional hydrogen so that the molal proportions of hydrogen and carbon monoxide in the total gas will be suitable for the methanol synthesis.

The effluent from the shift converter, is cooled and flows to the purification section where carbon dioxide is removed by scrubbing synthesis gas with a solution of monoethanolamine.

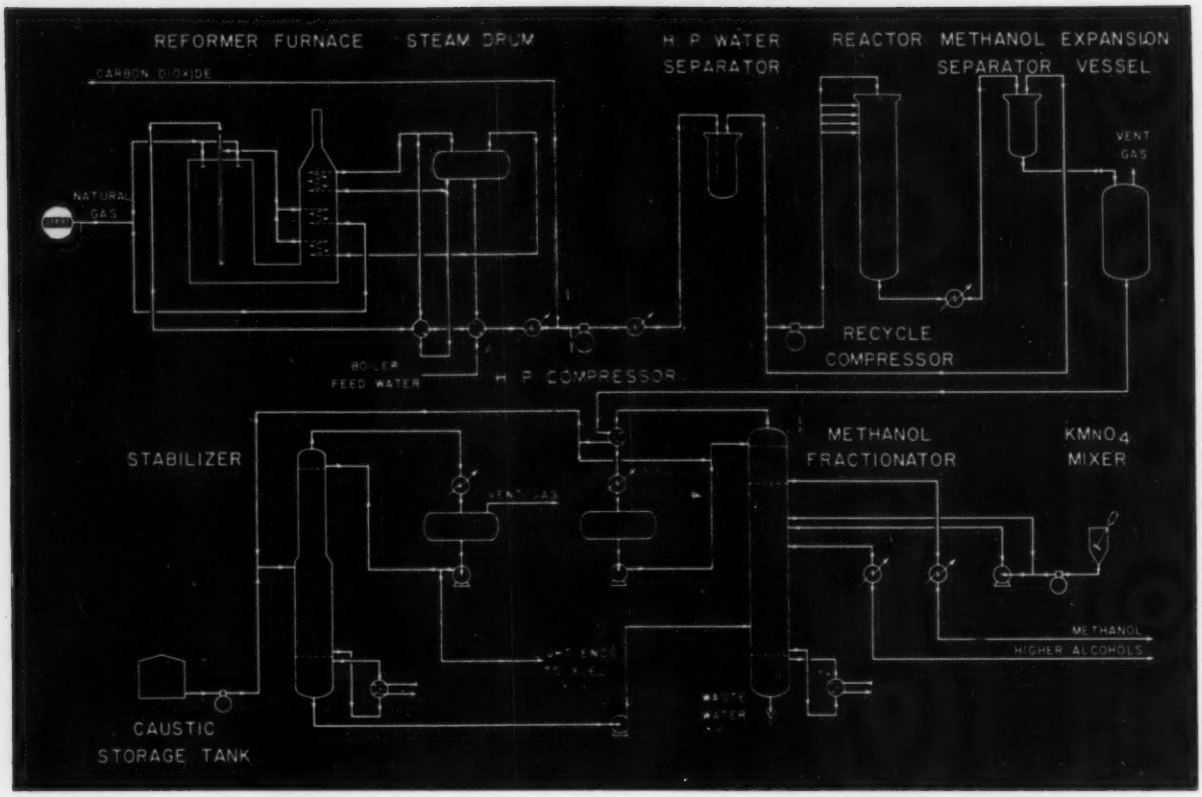
The purified gas, now mainly hydrogen and carbon monoxide, is compressed to approximately 6500 psig and enters the Casale reactor in which the catalytic synthesis to methanol takes place. The reactor effluent is partially condensed and flows to a two-stage separating system in which unconverted hydrogen and carbon monoxide is separated, compressed and returned, as recycle, to the Casale reactor. The liquid from the low pressure separator is crude methanol which flows to storage.

Crude methanol is purified either by fractional or extractive distillation. In the former system, crude methanol is pumped to a fractionating column for the removal of light ends. These light ends (ether) are partially condensed and used as reflux to the column, and the uncondensed gases are vented to flare. The bottoms from this column flow to a methanol fractionating column where pure methanol is recovered as a side stream. A second side stream of higher alcohols, with some methanol and water is also withdrawn from the column and the water is rejected from the bottom.

The purified methanol stream next passes into a small stripper which removes the last traces of ether. The stripped product, pure methanol, is cooled and pumped into the product rundown tank.

Operating Conditions: Important operating conditions are described above.

Commercial Installations: 100 ton/day installed capacity.



Methanol (Uhde)—ARTHUR G. McKEE & COMPANY

Application: A process for manufacturing synthetic methanol.

Charge: Natural gas, ethane, LPG, any light hydrocarbon.

Product: Pure andydrous methanol.

Description: Methanol is produced by the reaction of carbon monoxide or carbon dioxide with hydrogen. The process is catalytic and carried out at elevated temperature and pressures. Any suitable source of H_2 and CO or CO_2 may be used to produce the synthesis gas. Under U. S. economic conditions the most favorable source is high-pressure reforming of natural gas with steam.

Steam-methane reforming produces a gas in which the ratio H_2/CO is higher than desirable for the methanol reaction. This ratio is theoretically 2.0, but a ratio of 2.25 is normal practice. To achieve the desired balance, carbon dioxide from any available outside source may be added in the H_2/CO_2 ratio of 3.25 to react with excess H_2.

In steam-methane reforming the natural gas at approximately 150 F. is preheated to 850 F. and mixed with steam likewise preheated to 950-1000 F. The mixture passes to a bank of catalyst tubes in the radiant section of a furnace. High temperatures favor the reforming reaction. Excess steam is used to insure complete utilization of the methane.

Leaving the catalyst tubes the mixture is quenched with water to bring its temperature below reaction temperature as quickly as possible. It then exchanges heat with boiler feed water and is cooled with water before going to the high pressure compressor. Carbon dioxide required to achieve the desired $H_2/CO + CO_2$ ratio is added before the mixed gases go to the high pressure compressor. This compressor raises the pressure of the mixture to that of the reactor system, 4600 psig.

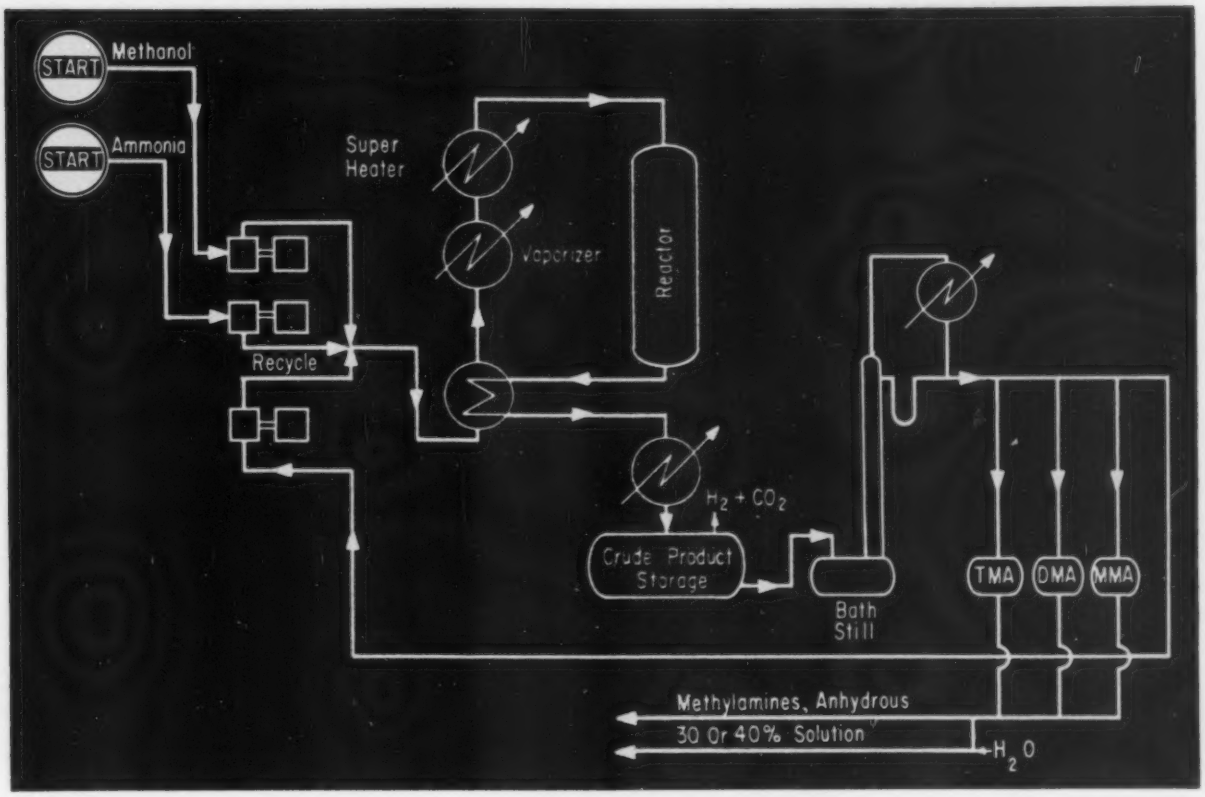
The Uhde methanol reactor has four beds of catalyst mounted in a high-pressure container. The main body of reacting gas enters at the top of the vessel and passes down along the shell through an annular space. This preheats the gas and keeps the pressure shell cool. The pressure shell can therefore be constructed of carbon steel. At the bottom the gas passes through the shell side of a shell-and-tube-type exchanger built within the pressure shell. Here it is heated by the reaction products leaving the convertor. Leaving the heat exchanger the feed gases pass through a central tube to the top of the reactor and then down through the first bed of catalyst.

The reaction of H_2 and CO is strongly exothermic. To regulate the temperature over the catalyst some of the feed gas by-passes the preheater. It enters directly into the space between the catalyst beds cooling the gases leaving the catalyst bed above.

The gases leaving the bottom catalyst bed pass through the tube side of the internal heat exchanger before leaving the reactor. They are then cooled with water and pass to the methanol separator where the condensed methanol is withdrawn. The unreacted gases are returned to the reactor by the recycle compressor. The methanol is depressured to an expansion vessel in which the dissolved gases are flashed and vented. It is then stabilized to remove light ends (ethers, hydrocarbons and noncondensibles). A small amount of caustic solution is added with the stabilizer feed to neutralize the acids formed as by-products.

The stabilized methanol is charged to the methanol fractionator for purification. A recycled sidestream withdrawn from the fractionator is treated with 1 percent potassium permanganate solution to remove aldehydes, etc., by oxidation. The overhead product of this fractionator is returned to the stabilizer where it joins the light ends stream. The purified methanol is withdrawn as a sidestream. Higher alcohols are withdrawn farther down the fractionator. The sodium salts, MnO_2 and water are withdrawn to waste at the bottom of the tower.

Operating Conditions: The methanol synthesis is carried out at 4600 psig. In the catalyst beds the reacting gases enter at approx. 615 F.



Methylamines— NITTO CHEMICAL INDUSTRY COMPANY, LTD.

Application: A process for manufacturing methylamines.

Charge: Methanol and ammonia.

Product: Anhydrous mono-, di-, and trimethylamines.

Description: In normal operation, methanol, liquid ammonia and recycle are pumped into the preheater and then to the vaporizer. They are vaporized at 70-80 C and fed to the superheater and heated to approximately 450-460 C. This superheated feed then goes into the reactor which is essentially at superheater exit temperature and operates at about 200-250 psi.

The reactor is packed with silica-alumnia based catalyst and the reaction proceeds as follows:

$CH_3OH + NH_3 \rightarrow CH_3 \cdot NH_2 + H_2O$ (monomethylamine)
$2CH_3OH + NH_3 \rightarrow (CH_3)_2 \cdot NH + 2H_2O$ (dimethylamine)
$3CH_3OH + NH_3 \rightarrow (CH_3)_3 \cdot N + 3H_2O$ (trimethylamine)

Crude products from the reactor preheat the feed and then pass to a cooler and on to pressurized crude product storage.

Separation and purification of the crude product, which contains ammonia, mono, di, tri-methylamine and water, is accomplished by batch distillation. The boiling point of the three methylamines are very close together and trimethylamine forms an azetrope with ammonia, mono and dimethylamine.

Since ammonia is the most volatile constituent it is taken off in the first cut. However, some trimethylamine is also removed and recycled because of the azetrope formed with ammonia.

After removal of all ammonia-trimethylamine is removed, the monomethylamine is taken off as the second cut in high purity.

For the third separation, di- and trimethylamines, water is added to the top of the column and extractive distillation performed. Because dimethylamine is more soluble in water, it tends to wash down the column and accumulate in the still pot, the trimethylamine going overhead.

Since only dimethylamine remains in the still pot after the trimethylamine has been distilled off the last step is essentially "stripping" of the dimethylamine from the water solution.

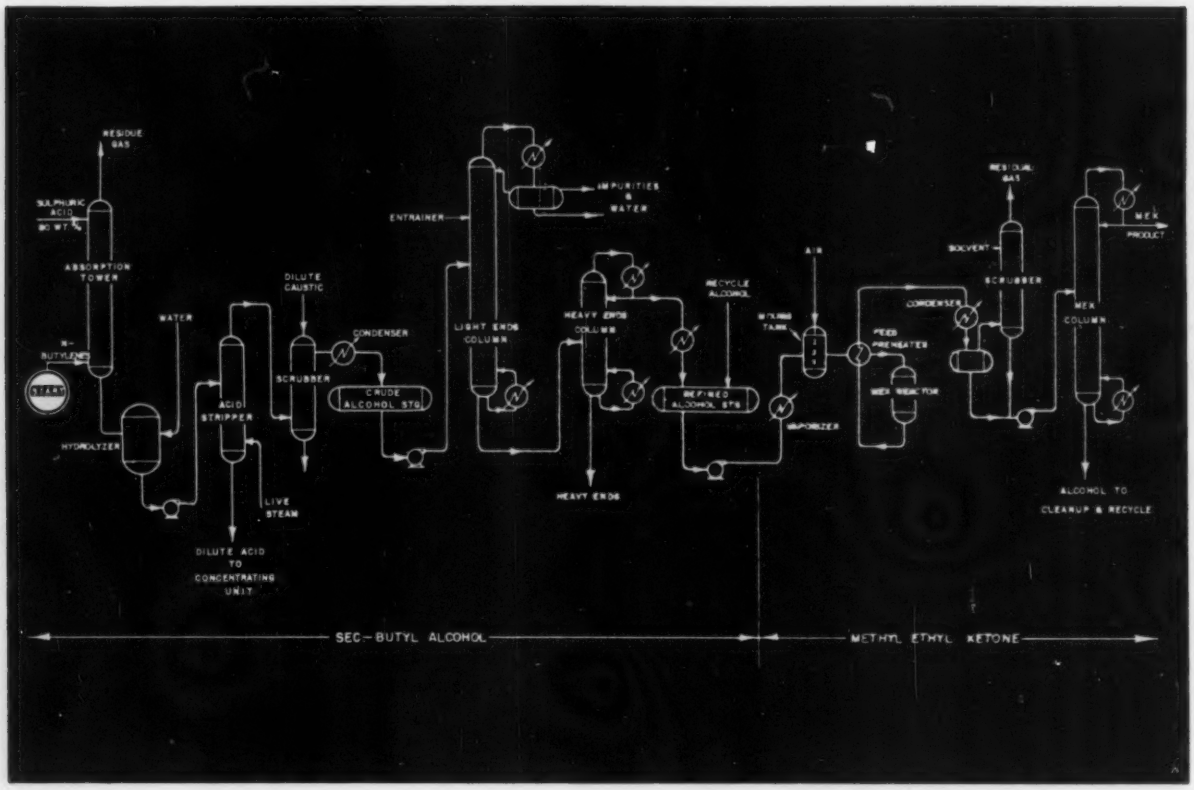
Methylamines are classified into anhydrous and aqueous amines. Aqueous amines are the 40 percent solutions of mono- and the dimethylamine and the 30 percent solution of trimethylamine. Specifications of methylamines are:

	ANHYDROUS			AQUEOUS		
ITEM	MMA Percent	DMA Percent	TMA Percent	DMA 40 Percent	DMA 40 Percent	TMA 30 Percent
MMA	98.5>	0.5<	0.5<	39.5>	0.2<	0.2<
DMA	0	95.0>	3.0<	0.0	39.5>	1.0<
TMA	1.5<	2.5<	95.0>	0.4<	1.0<	29.5>
NH_3	0	0	0	0	0	0

The anhydrous methylamines are shipped in steel containers or tank cars fitted with iron or steel valves. Copper alloy should be avoided. Aqueous amines are normally sold in 55 gallon steel drums.

Operating Conditions: Important operating conditions are described above.

Commercial Installations: Nitto Chemical Industry Co., Ltd., Tokyo, Japan, has operated a plant since 1954 with present capacity of 1 million pounds annually.



Methyl Ethyl Ketone and Acetone

Application: This process is for the manufacture of methyl ethyl ketone (MEK).

Charge: A mixture of normal butylenes.

Product: The product is methyl ethyl ketone (99 percent purity).

Description: Gaseous butylenes are charged to the absorption tower which operates at pressures slightly above atmospheric and at a temperature of 110 F. Sulfuric acid (about 80 percent) is fed to the top of the tower and reacts with the butylenes to form butyl sulfates. The reaction is exothermic, and internal cooling is provided.

Conversion of butylenes is practically complete. The mixture of acid and butyl sulfates flows to hydrolyzer where alcohols are formed from the sulfates. *Sec*-butyl alcohol is the principal product.

The hydrolizate is fed to the acid stripper and alcohols are steam stripped from the acid. Entrained acids in the alcohol stream are removed in a dilute (8-10 percent) caustic scrubber. The scrubbed vapors are condensed. The crude contains 10-20 percent water, light organics, *sec*-butyl alcohol and heavier organics.

The major problem in the purification is the separation of the *sec*-butyl alcohol from water. This is done in a tower to which an entrainer material, such as diisobutylene, is added. The entrainer forms light-boiling ternary azeotropes with the impurities and water. These azeotropes are taken overhead. *Sec*-butyl alcohol is separated from the heavy ends in the heavy ends column.

The *sec*-butyl alcohol is vaporized and fed to a mixing tank where it is combined with a small amount of air. The mixture, at 250-300 F., is heated to 750 F. and fed to the reactor.

The reactor contains a number of small-diameter tubes packed with supported zinc oxide catalyst. The reaction is exothermic, maximum temperature about 1000 F., with a combined oxidation-dehydrogenation of the alcohol to MEK.

The reactor effluent contains MEK, unconverted alcohol, hydrogen and other fixed gases. The mixture passes through a preheater and a brine-cooled condenser. Equilibrium amounts of MEK and alcohol remaining in the vapor are recovered in a separate column by absorption in a non-volatile solvent.

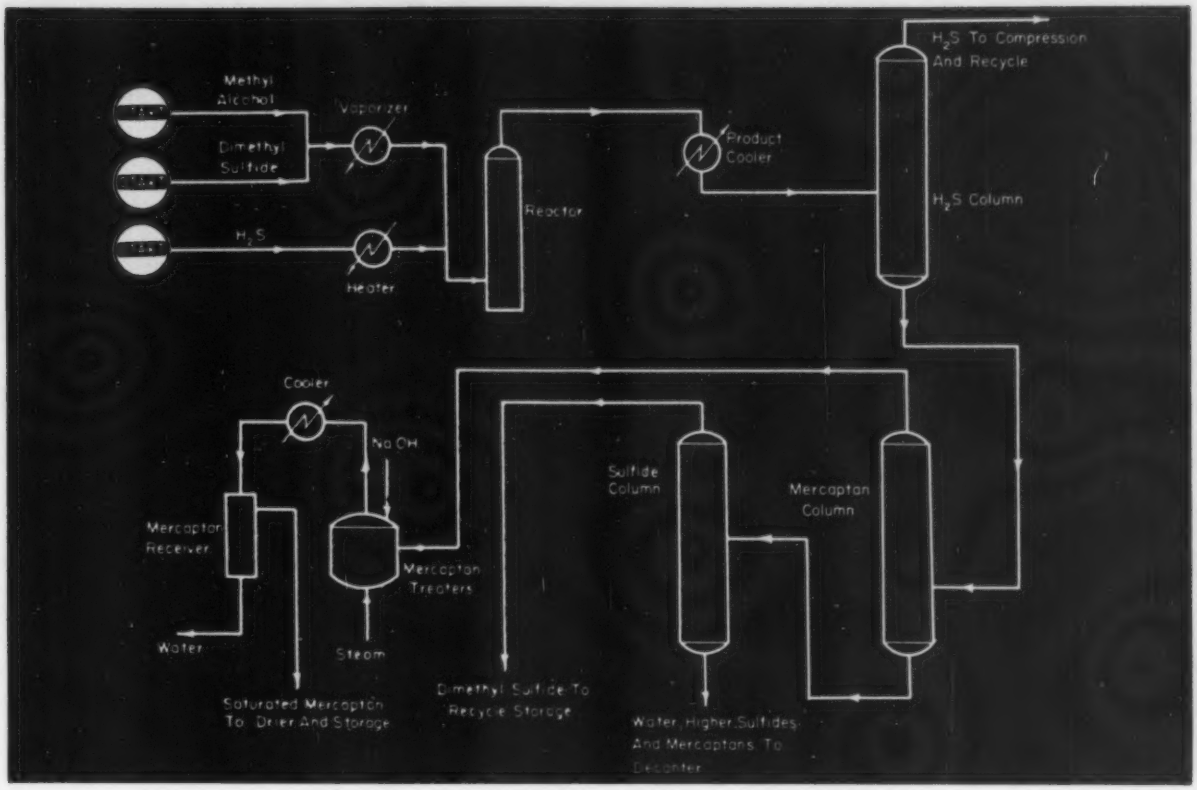
The combined liquid streams from condenser and scrubber are fed to a fractionator where MEK with a minimum purity of 99.0 weight percent is removed overhead.

Acetone is made primarily from isopropyl alcohol by a similar combined oxidation-dehydrogenation reaction such as described above.

Yields: Over-all process yield, MEK from butylene, is 75-80 percent.

Commercial Installations: This process or a variation is used for making MEK at the following plants: Esso Standard Oil Company, Linden, N. J.; Shell Chemical Company, Deer Park, Texas, Martinez, Calif. and Dominguez, Calif.; Stanolind Oil Gas Company, Brownsville, Texas.

Reference: PETROLEUM REFINER, Feb.'54,p141.



Methyl Mercaptan

Application: A process for the manufacture of methyl mercaptan from its alcohol.

Charge: Raw materials to this process are methyl alcohol, hydrogen sulfide and recycle dimethyl sulfide.

Products: Methyl mercaptan, dimethyl sulfide and higher sulfides.

Description: Alcohol and recycle dimethyl sulfide are vaporized and are mixed with a heated, compressed H_2S stream before entering the fixed bed reactor. Effluent from the reactor is partially condensed and then flows to a primary column, where excess H_2S is removed by distillation. The overhead from this column is refrigerated.

Bottoms from the H_2S column, essentially H_2S free, is fed to the mercaptan column where methyl mercaptan is removed overhead. Water, dimethyl sulfide and higher sulfides, which are the bottoms from the mercaptan column, are fractionated in the sulfide column where dimethyl sulfide is taken overhead. Water and heavier sulfides flow to a cooler-decanter where water of reaction is removed and higher sulfides are recovered if desired.

The mercaptan recovered in the second column of the fractionation train contains small quantities of H_2S which must be removed if the mercaptan is to be used in certain types of subsequent processing. This can be done in a batch treater where the mercaptan is dissolved in a 20 percent NaOH solution. The hydrogen sulfide is converted to the sodium salt. The mercaptan reacts with the sodium hydroxide to form a thermally unstable salt. Heating reverses this reaction and liberates the mercaptan from solution. Residual traces of mercaptan in the caustic can be recovered by steam stripping. Mercaptan recovered in the stream stripping step is decanted and the total product is dried. For large scale production this operation can be made continuous.

Methyl mercaptan is synthesized from the alcohol by the following reaction:

$$CH_3OH + H_2S \rightarrow CH_3SH + H_2O$$

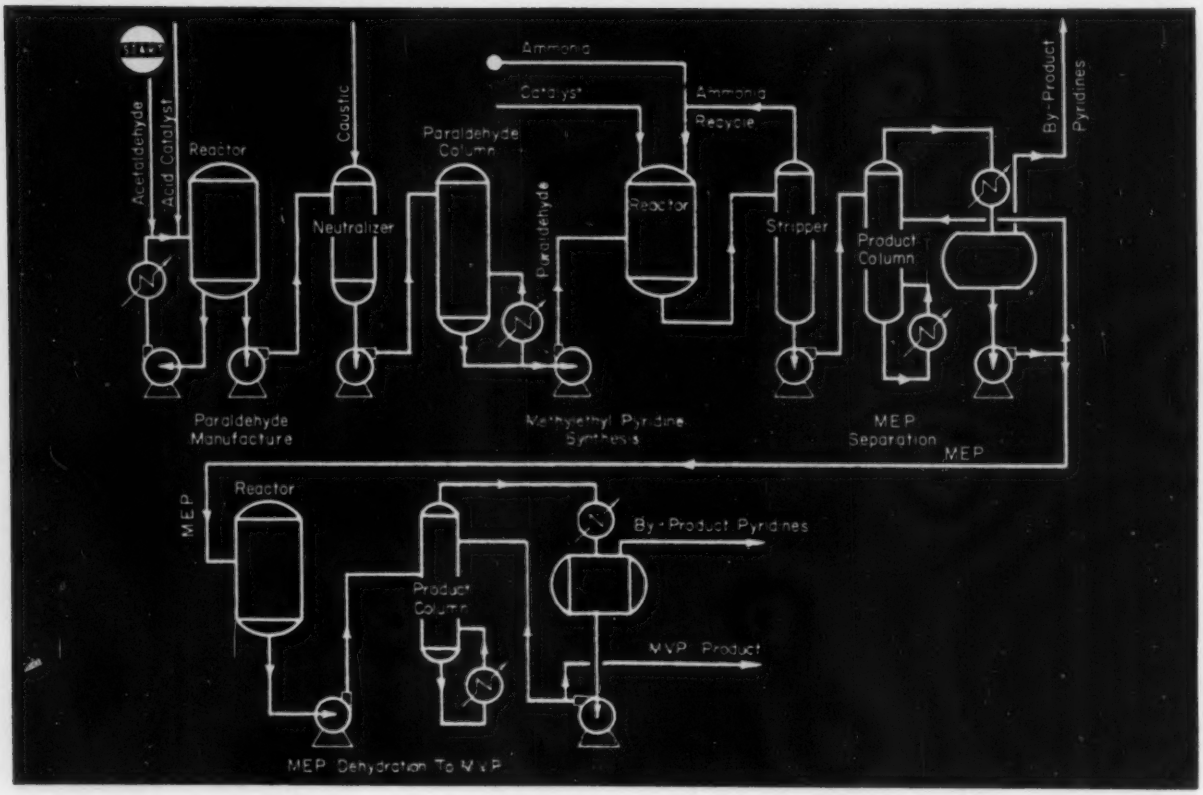
The secondary reaction which takes place is:

$$2\,CH_3SH \rightleftharpoons (CH_3)_2S + H_2S$$

An excess of H_2S tends to minimize the extent of this reaction and recycle sulfide is converted to mercaptan by this means.

Several catalysts have been used for this reaction. Among these are 5 percent thoria in alumina, silica alumina, high density 12 percent thoria in alumina, thoria-cobalt. A pellet size of ⅛ inch has proven satisfactory. The H_2S ratio can be varied from 3:1 to 8:1 with respect to total methyl radical input depending on the amount of sulfide recycled. Reactor temperatures vary from 600-875 F. depending on feed and catalyst with a pressure of 125-225 psia proving satisfactory.

Handling H_2S introduces special problems in materials of construction in this system, where water of reaction is present.



Methyl Vinyl Pyridine

Application: This process is for the manufacture of methyl vinyl pyridine.

Charge: Acetaldehyde and ammonia.

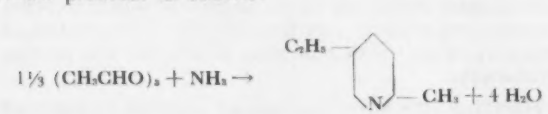
Product: The product is methyl vinyl pyridine.

Description: The first step in the synthesis is to convert acetaldehyde into paraldehyde. This is done by trimerization of three moles of acetaldehyde to one mole of paraldehyde in the presence of sulfuric acid and catalyst.

$$3\,CH_3CHO \xrightarrow[\text{Catalyst}]{H_2SO_4} (CH_3CHO)_3$$

This polymerization is continuous with make-up acetaldehyde and sulfuric acid being fed continuously to the reactor. An external heat exchanger is used to remove the heat of reaction. Before purification by fractionation of the paraldehyde for the Methyl Ethyl Pyridine (MEP) synthesis the acid is neutralized by addition of caustic.

The liquid phase reaction of paraldehyde with ammonia proceeds as follows:

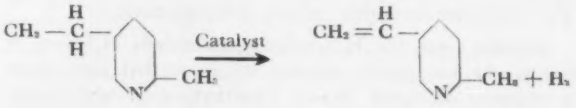


Along with MEP a certain amount of 2-picoline, 4-picoline and heavy pyridines are formed. Ammonia in excess of theoretical requirements is used.

Crude product is next sent to the separation section and the various pyridine recovered as technical grades. Excess ammonia is recycled and certain fractions sent back for rerun. MEP fraction is transferred to intermediate storage before going to the Methyl Vinyl Pyridine (MVP) synthesis section.

MEP is recovered as a clear liquid of 345-356 F. boiling range at atmospheric pressure. MEP has other end uses than the manufacturing of MVP.

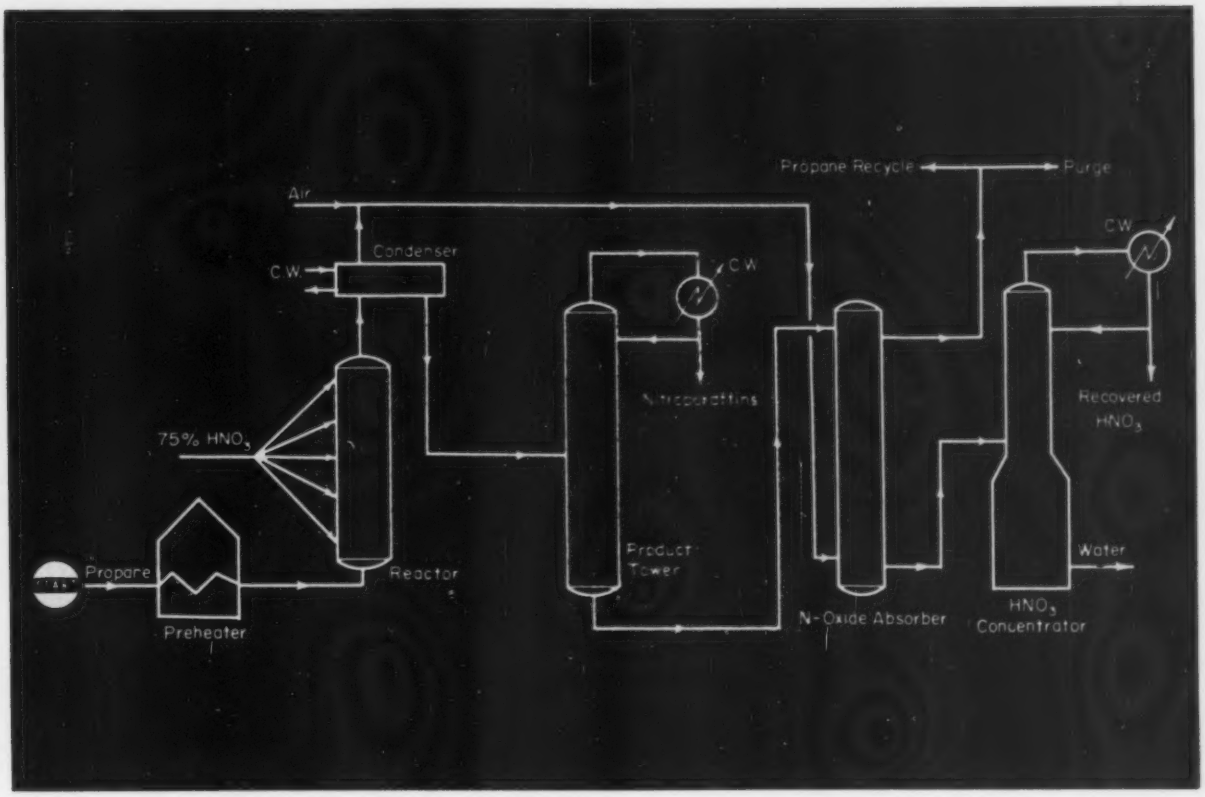
MEP dehydrogenation to Methyl Vinyl Pyridine proceeds as follows:



Along with the main product MVP (2-methyl-5-vinyl pyridine) certain by-products are also produced as in the methyl ethyl pyridine synthesis. MVP is recovered as a final product.

Commercial Installations: A plant using a process similar to this is operated by Phillips Chemical Company, Adams Terminal, Houston.

Reference: *Petroleum Processing*, Dec.1952,p1802.



Nitroparaffins

Application: A process for the manufacture of nitroparaffins from propane.

Charge: Propane and 75 percent nitric acid.

Products: Nitromethane, nitroethane, 1-nitropropane, and 2-nitropropane.

Description: Propane gas is heated to 430-450 C. in a furnace and enters a glass or silica-lined reactor. The 75 percent nitric acid is sprayed into the gas stream at several points. The amount of acid from each spray is adjusted so that the heat of vaporization of the water in the acid counteracts the exothermic heat of the reaction to maintain the temperature at 390-440 C. The over-all mole ratio of propane: nitric acid is 5:1, with the stagewise addition limiting the ratio at any one stage to 25:1.

It is important that pyrolytic temperatures be avoided in order to prevent carbon skeleton rearrangements. At the proper nitration temperatures some decomposition of the various nitrated and oxidized compounds does not occur and therefore some olefins and degraded products are formed. The pyrolysis of nitroethane and 1-nitropropane gives olefins, aldehydes, carbon dioxide, and nitrogen.

Nitric acid and nitrogen dioxide give the same products, but nitric acid gives better yields and higher nitration rates. Comparison of various reaction rate studies shows that the substitution of any hydrogen atom can be effected more readily by nitric acid than by nitrogen dioxide. Some experimental runs show four times the yield using nitric acid rather than nitrogen dioxide.

The gas leaving the reactor is cooled in a partial condenser. The nitroparaffins and dilute nitric acid are condensed while propane and gaseous oxidation products pass to recovery units from which recovered propane is recycled. The condensate separates into two layers. The lower dilute nitric acid layer is fed back to the nitrator as makeup, after fortification with fresh nitric acid. The upper nitroparaffin layer is fractionated into the four products of the reaction.

Under the conditions of the reaction the products obtained will represent all possible ones in which the nitro group replaces either a hydrogen or any alkyl group in the hydrocarbon feed. Close control of the reaction is necessary to avoid excessive losses by oxidation.

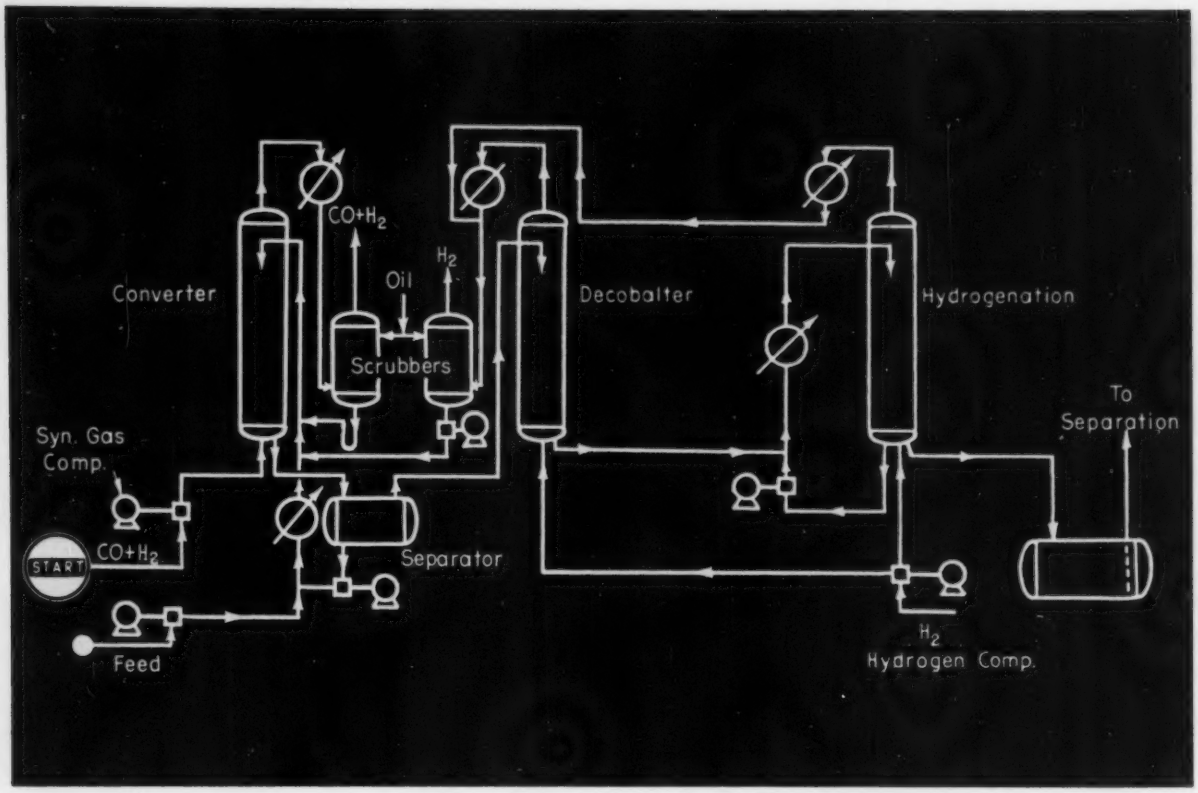
Yields: Yields of 40 percent per pass based on nitric acid conversion to nitroparaffin are reported.

EFFECT OF TEMPERATURE ON PRODUCTS NITRATING PROPANE

PRODUCT	500-510 C. Mole %	790-800 C. Mole %
Nitromethane	22.0	32.2
Nitroethane	16.6	24.2
1-nitropropane	13.2	24.2
2-nitropropane	48.2	19.3

Commercial Installation: This process is in commercial use by Commercial Solvents Corporation at Peoria, Ill.

References: Hass and Schechter, *Industrial and Engineering Chemistry*, 39,p817 (1947). P. H. Groggins (Ed.), *Unit Processes in Organic Syntheses*. 4th Edition,pp2-14 and 77-79. New York, McGraw-Hill Publishing Co., 1952.



OXO Process

Application: A process for the hydroformylation of olefins.

Charge: Carbon monoxide, hydrogen and an olefin.

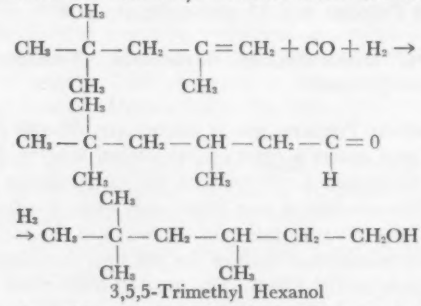
Product: An aldehyde containing one more carbon atom than the hydrocarbon feed stock.

Description: The synthesis gas (carbon monoxide and hydrogen) is compressed to converter pressure (100-250 atmospheres) and introduced to the bottom of the converter. At the same time the olefin feed is introduced into the top of the converter. The overhead is cooled and scrubbed for recovery of carbonyl product and returned to the converter. The synthesis gas is recycled. The bottoms from the converter is separated with the light product going to the decobalter and the heavy product being recycled to the converter. The overhead from the decobalter is cooled and scrubbed for recovery of carbonyl product and re-introduced as feed to the converter. Hydrogen is introduced in the bottom of the decobalter and is recycled from the overhead scrubber. This decobalted product is fed to the top of the hydrogenation vessel. The overhead product from the hydrogenation vessel is cooled and scrubbed and returned as feed to the converter. The hydrogen from the scrubber is recycled. Hydrogen is introduced into the bottom of the hydrogenation vessel to convert the Oxo aldehydes into the corresponding alcohols.

Operating Conditions: Synthesis gas having a volume ratio of 1:1 for carbon dioxide and hydrogen. Temperature range of 120-145 C. and pressure range of 100-250 atmospheres.

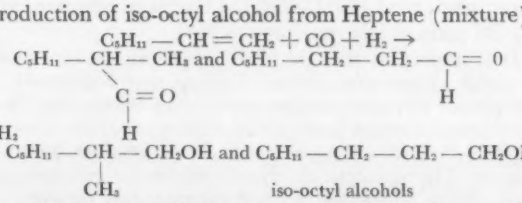
Reactions: Typical reactions using the Oxo process are as follows:

Production of Trimethyl hexanol from di-isobutylene



3,5,5-Trimethyl Hexanol

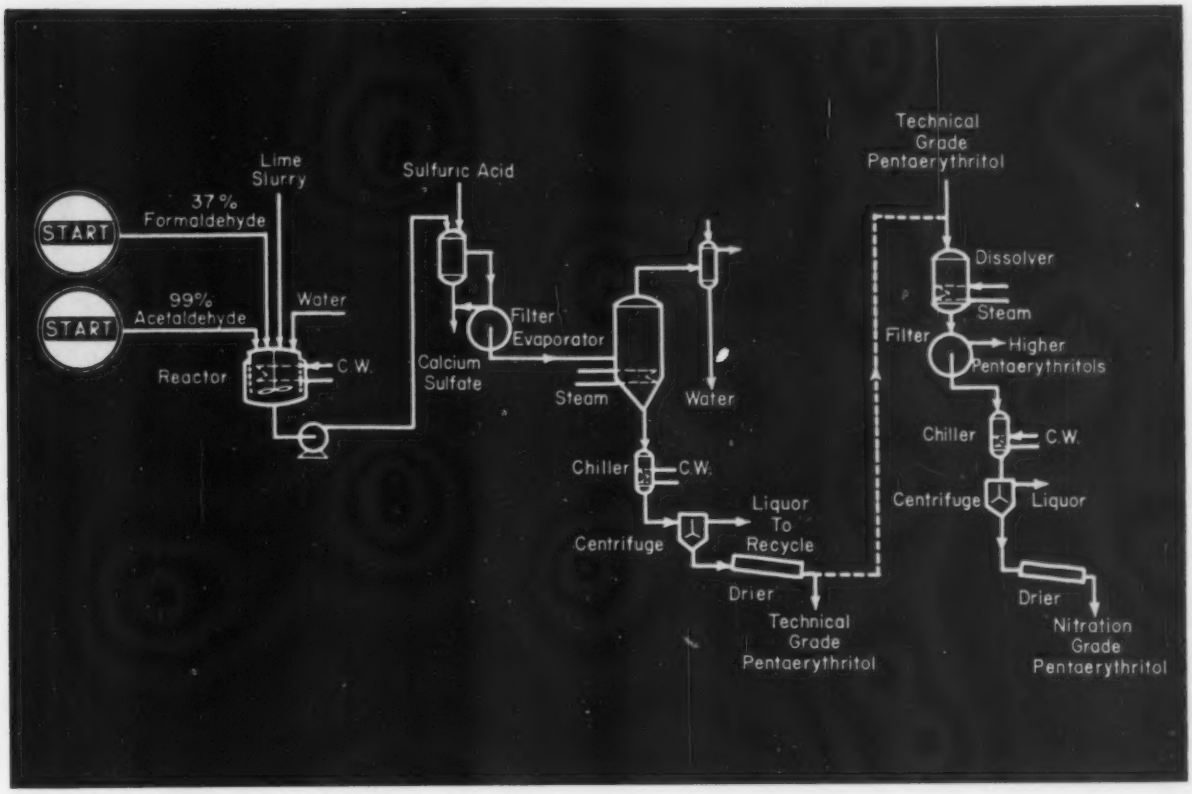
Production of iso-octyl alcohol from Heptene (mixture)



iso-octyl alcohols

Commercial Installations: A process similar to this is employed by Standard Oil Company, Baton Rouge, La., Gulf Oil Company, Port Arthur, Texas, Tennessee Eastman Company, Longview, Texas.

References: PETROLEUM REFINER, Dec.,1954,p141;Dec. 1956,p197,Aug.1957,p141; *Chemical and Engineering News,* Feb.14,1955,Vol.33,No.7,p594.



Pentaerythritol

Application: A process for the manufacture of pentaerythritol, $C(CH_2OH)_4$.

Charge: Formaldehyde, 37 wt-percent aqueous solution; acetaldehyde, 99+ percent purity.

Product: Crystalline pentaerythritol, either technical grade (85-90 percent purity) or nitration grade (99 percent purity).

Description: Pentaerythritol is produced commercially by a batch-wise reaction between formaldehyde and acetaldehyde in an alkaline medium. Chemically, two successive reactions take place. In the first, an alkali-catalyzed aldol condensation produces pentaerythrose:

$$3\,HCHO + CH_3CHO \xrightarrow{\text{alkali}} C(CH_2OH)_3CHO$$

In the second step, the alkali (here shown as calcium hydroxyde) enters the reaction process, and monopentaerythritol is formed:

$$HCHO + C(CH_2OH)_3CHO + Ca(OH)_2 \rightarrow C(CH_2OH)_4 + Ca(COOH)_2$$

In practice, both reactions occur during a single batch operation. The reactor is of conventional design, being equipped with cooling coils and jacket, and mechanical agitator.

Weighed amounts of formaldehyde solution and lime slurry are placed in the reactor, the amount of lime being 10-15 percent in excess of that required stoichiometrically. Water is then added to adjust the formaldehyde concentration to about 15 percent. Liquid acetaldehyde is next introduced beneath the liquid surface, agitation and cooling being controlled to give a mixing temperature of 70-80 F. The acetaldehyde addition is complete when the formaldehyde:acetaldehyde molar ratio is 4.5-5.0 to 1.0.

The reaction is carried out for several hours, with the temperature being varied from 80 to 140 F. Careful attention must be given to the time-temperature relationship in order to insure a product of good quality and yield. Overheating causes formation of complex sugars which contaminate the product. Under heating causes uneconomically-long reaction times and inadequate yields. In general, some 4-5 hours are required, during most of which the reactor contents are below 100 F. In this discussion, lime is considered as the alkali in accordance with general practice, but caustic soda is also used.

When the reactor contents show a total aldehyde concentration of less than 0.1 percent, they are pumped to the neutralizing tank where dilute sulfuric acid is added to lower the pH to about 8.0. This precipitates calcium sulfate, which is in turn filtered off. If sodium hydroxide is used in the process, neutralization is effected by formic acid and this filtration step is not required since the sodium formate is soluble.

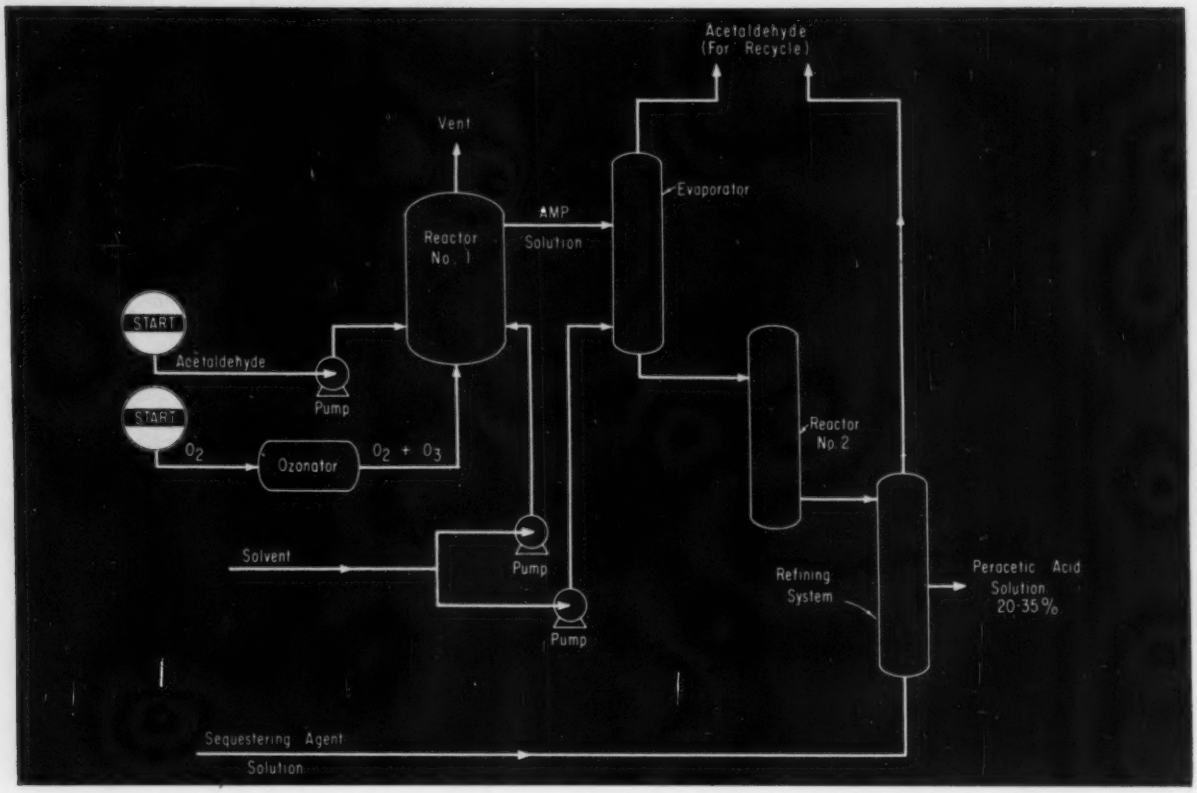
The filtrate passes to a vacuum evaporator where most of the water is removed. The thick liquor has a specific gravity of about 1.27 and contains some precipitated pentaerythritol. Precipitation is completed in a water-cooled vessel, and the crystals separated by centrifuging. The mother liquor is recycled to the evaporator for further recovery of pentaerythritol. The moist crystals are dried to yield technical grade product, which contains some 85-90 percent monopentaerythritol with dipentaerythritol as the principal inpurity. About 90 percent of the industrial production of pentaerythritol is technical grade.

For the production of nitration-grade material, the technical product is re-dissolved in hot water, decolorized with charcoal, and filtered at 170 F. or higher. The filtrate is then cooled, with essentially pure monopentaerythritol crystallizing out. The crystals are separated by centrifuging and finally dried to yield the nitration-grade product of 99 percent purity.

Yields: The yield of total pentaerythritols is 85-90 percent, based on acetaldehyde charged.

Commercial Installations: This process or a modification is used by: Commercial Solvents Corporation, Agnew, Calif.; Delaware Chemicals, Inc., Staten Island, N. Y.; Hercules Powder Company, Mansfield, Mass., and Louisiana, Mo.; Heyden Chemical Company, Garfield, N. J.; Reichhold Chemicals Company, Tuscaloosa, Ala.; St. Maurice Chemicals, Ltd., Varennes, Quebec; Trojan Powder Company, Seiple, Pa.; Warren Petroleum Company, Conroe, Texas; Canadian Chemicals Co., Edmonton, Alta.

Reference: Reaction variables are discussed by M. S. Peters and J. A. Quinn, *Ind. Eng. Chem.*, Vol.47,1710(1955), PETROLEUM REFINER 35, (11)p173(1956).



Peracetic Acid from Acetaldehyde—UNION CARBIDE CHEMICALS COMPANY

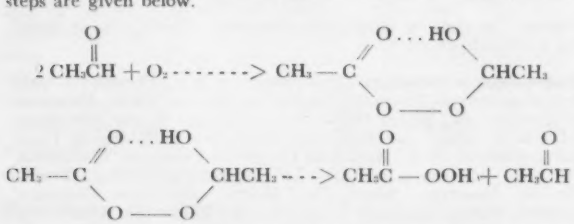
Application: A process for manufacturing peracetic acid, primarily for use in organic oxidation reactions.

Charge: Acetaldehyde, Oxygen (or air), Solvent. Esters and ketones are preferred solvents. Choice depends on the planned use for the peracetic acid.

Product: Peracetic acid is obtained from the process as a 20 to 35 percent solution in the chosen solvent. A small amount of acetic acid (less than 10 percent), formed as a by-product, may also be present. A sequestering agent such as sodium pyrophosphate is added to the product solution to inactivate any traces of heavy metal ions, which otherwise would lower the stability of the peracid by catalyzing its decomposition.

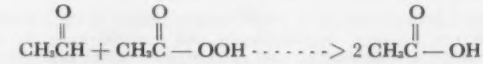
Pure peracetic acid has a melting point of 0 C. and a boiling point of 110 C. It is customarily handled only in dilute solution, since in concentrated form it is subject to detonation by heat and shock.

Description: The process consists of two steps. Acetaldehyde is first oxidized below 0 C. to acetaldehyde monoperacetate (AMP), an unstable peroxide which decomposes violently to acetic acid if allowed to warm up under ordinary conditions. The AMP is then decomposed either thermally or catalytically to peracetic acid and acetaldehyde. Equations for these two steps are given below.



The first reaction may be catalyzed by ozone, ultraviolet light, or heavy metal salts such as cobalt acetate. Ozone and ultraviolet light are preferred because metal ions, if not subsequently completely removed or deactivated, lower the stability of the peracetic acid.

The second reaction may be conducted either by non-catalytic pyrolysis or by heating the AMP solution in the presence of an acidic catalyst. In either case, continuous removal of acetaldehyde from the mixture is necessary to prevent its destroying the peracetic acid by the oxidation-reduction reaction shown below

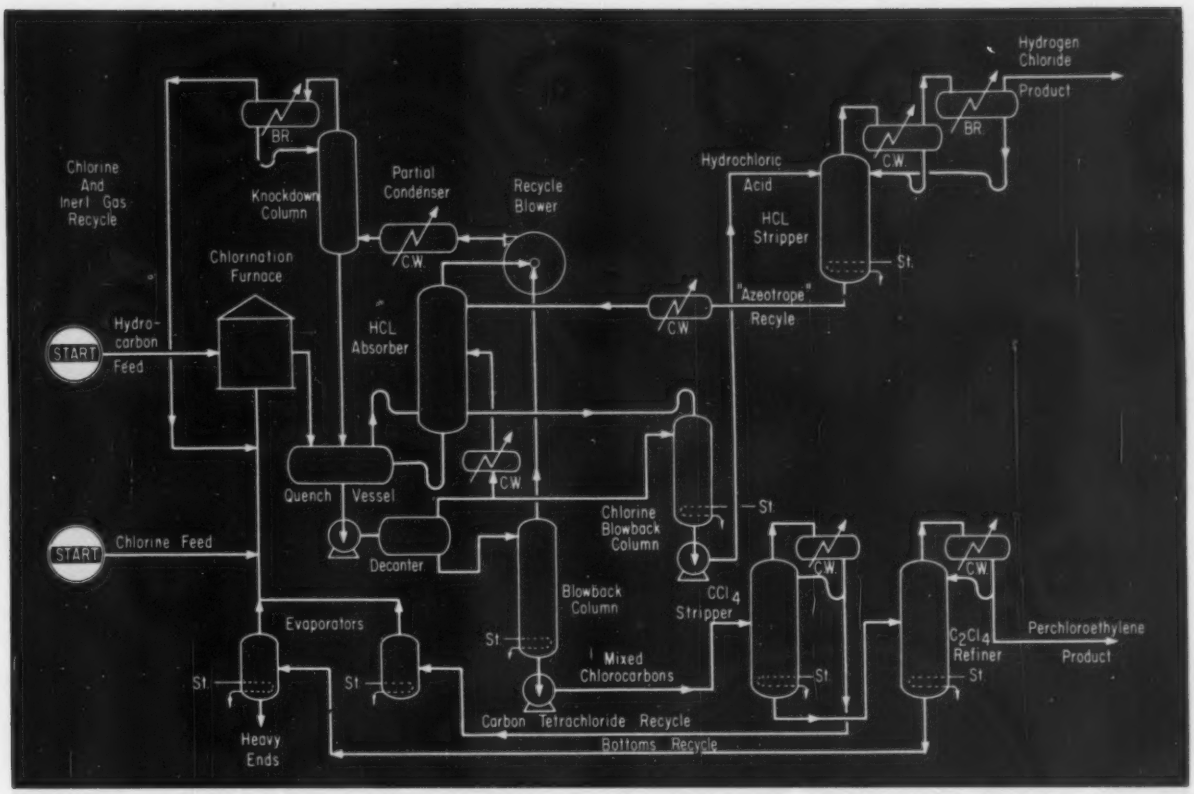


In one modification of the process, oxygen is first fed through an ozonator, in which approximately 3 percent of it is converted to ozone. This ozonated oxygen is then sparged into a 75 percent solution of acetaldehyde in acetone, contained in a tank reactor (Reactor No. 1) operated at a temperature of 0 C. and a pressure of one atmosphere. Fresh acetaldehyde and acetone are continuously pumped into the reactor, and there is continuously withdrawn a solution containing 50 percent AMP by weight. Next, unreacted acetaldehyde is removed by distillation under reduced pressure, the solution being simultaneously diluted with additional acetone to avoid crystallization of AMP. The solution of AMP in acetone is then fed to the second reactor, in which the AMP is pyrolyzed at 100 C. and a pressure of 200 mm. Hg absolute. Complete vaporization of the solution occurs under these conditions. The gases pass to the refining system, where fractionation is effected, giving acetaldehyde for recycle and a product solution containing 30 percent of peracetic acid, 64 percent of acetone, and 6 percent of acetic acid (formed as a by-product in the process).

Yield: Chemical yield of 80 percent theoretical, based on acetaldehyde consumed.

Commercial Installation: Union Carbide Chemicals Company is now constructing a large commercial unit at Institute, W. Va. It is scheduled for completion in 1958.

Reference: U. S. patent 2,804,473.



Perchloroethylene— SCIENTIFIC DESIGN COMPANY, INC.

Application: A process to produce perchloroethylene.

Charge: Oxygen free chlorine and an inert free hydrocarbon such as natural gas, LPG, or any mixture lighter than butane.

Products: The principal product is refined perchloroethylene, C_2Cl_4.

Description of Process: Chlorine, hydrocarbon, and several recycle streams are mixed and fed to the chlorination furnace. The chlorination process proceeds readily at high temperatures, sustained by the heat of reaction, without the aid of catalyst. From the furnace the reaction products go to a quench vessel where they are suddenly cooled.

The liquid quench mixture, consisting of carbon tetrachloride, perchloroethylene, and aqueous hydrochloric acid is decanted to separate acid from the chlorocarbons. Part of the acid is cooled and returned to the HCl absorber. The chlorocarbons are stripped in a blow-back column.

The mixed chlorocarbons from the stripping column are then fractionated first in a carbon tetrachloride stripper. The carbon tetrachloride overhead is recycled to the furnace. The remaining crude perchloroethylene is refined to yield high purity product, and the bottoms from the refining column are also recycled to the furnace.

Unquenched gases from the quench vessel pass to an HCl absorber where hydrogen chloride is absorbed in weak acid. The remaining gases from this absorption column are compressed by a recycle blower. Excess chlorine from the absorption system passes through a rectifying column. The excess chlorine overhead is recycled to the furnace.

The strong hydrochloric acid from the HCl absorber is also partially stripped to remove traces of dissolved chlorine and other contaminants which are returned to the HCl absorber. The purified hydrochloric acid is then sent to a conventional HCl stripping system, which yields anhydrous hydrogen chloride gas as the by-product of the process. Weak acid, close to the azeotropic composition, is recycled as scrubber liquor.

All equipment is of corrosion resistant alloy or nonmetallic material of construction. In particular equipment which handles hydrogen chloride is fabricated with a ceramic lining or of impervious graphite. The chlorination furnace and the quench vessel pose extremely stringent problems in mechanical design, and involve some radically new techniques of fabrication.

Possible chemical reactions depend upon the hydrocarbon feedstocks. The following are examples:

(1) $2\,CH_4 + 6\,Cl_2 \rightarrow C_2Cl_4 + 8\,HCl$
(2) $2\,C_2H_6 + 10\,Cl_2 \rightarrow 2\,C_2Cl_4 + 12\,HCl$
(3) $2\,C_3H_8 + 14\,Cl_2 \rightarrow 3\,C_2Cl_4 + 16\,HCl$

Operating Conditions: The chlorination furnace operates near atmospheric pressure at a temperature of 900-1200 F. The quench vessel, where rapid quenching is essential, operates at a low temperature. The absorption, stripping and fractionating columns operate at moderate temperatures and pressures.

Yields: The yield of products approaches 100% of theoretical. For example, one plant was designed to yield 20 pounds of perchloroethylene and 27 pounds of hydrogen chloride from 45 pounds of chlorine and 4 pounds of propane.

Commercial Installations: Pechiney Compagnie de Products Chimiques et Electrométallurgiques, St. Auban, France.

Reference: PETROLEUM REFINER, Oct.,'54,p131.

Acetone
Vac.
SOLID
PHENOL
Crystallizer
Acetophenone
Phenol
Tower
Cumene
Tower
Recycle Cumene + α-Methylstyrene
Water
Acetone
Tower
Water & Acid
Separator
Crude Phenol
CUMENE
PHENOL
Wash
Tower
Filter
Inert Gases
Cleavage
Vessel
Recycle Acid
Fresh Cumene
Hydrogen
START
START
Hydrogenator
Oxygen (Air)
Oxidizer
Dilute Sulfuric Acid

Phenol from Cumene

Application: A process for manufacturing synthetic phenol from cumene.

Charge: Cumene (isopropylbenzene), air, hydrogen, dilute sulfuric acid.

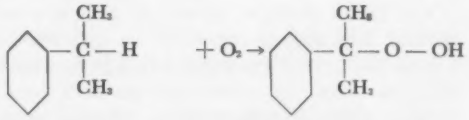
Products: Phenol (42.5-43 °C m. p.), acetone, acetophenone.

Description: Raw material cumene is obtained from the alkylation of benzene with propylene over a phosphoric acid catalyst. The propylene is usually derived from the products of propane cracking. The cumene is fractionated to a high degree of purity before being charged to the phenol unit.

Fresh and recycle cumene in a ratio of about 1:4 are mixed and sent to the hydrogenator. The recycle cumene contains about one percent alpha-methylstyrene and this must be removed before the cumene is oxidized. Hydrogen gas is bled into the reactor and the alpha-methylstyrene is converted directly to cumene. A suspended nickel catalyst is employed, together with mechanical agitation and a temperature of about 210 F. The effluent liquid contains less than 50 ppm alpha-methylstyrene.

The purified cumene is decanted from the catalyst, filtered, and pumped to the oxidizer. Intermediate storage is provided in order to buffer flow surges.

The oxidizer is a vessel containing an agitated oil-water emulsion. The contents are maintained at 265 F. Emulsifying agents such as sodium stearate or sodium lauryl sulfate are used. Air is injected under the surface and supplies the oxygen for reaction. An excess of cumene is used in order to utilize a substantial portion of the oxygen in the air. Cumene hydroperoxide is produced according to the reaction:

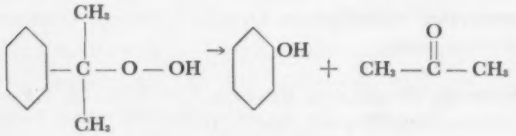


About 25 percent of the cumene is converted per pass. The liquid effluent is separated from fixed gases and sent to the cleavage vessel.

The reason for the oxidation being carried out in a dispersion of the hydrocarbon in an alkaline aqueous medium is to increase the rate of oxidation of benzene peroxide formation. The optimum conditions are with a pH of 8.5 to 10.5 which is easily maintained by using a sodium carbonate buffered solution.

Best results are obtained by using emulsifying agents. Sodium sterate of about 0.3 percent concentration seems to give best results. Other variables that effect this oxidation rate are: ratio of water and oil phases; peroxide concentration in the reaction mixture.

In the cleavage step the peroxide is decomposed in the presence of an acid. The reaction which occurs is:



The peroxide is completely decomposed. Dilute sulfuric acid is used and continuously recycled. The reactor effluent flows to a separator from which the oil layer, or crude phenol, is removed for further processing. The aqueous layer is recycled to the cleavage vessel.

Residual acid is removed from the crude phenol by countercurrent scrubbing with water in a packed tower. The washed oil has the following approximate composition:

	b.p., °F.	Weight-percent
Acetone	134	8
Cumene	307	76
Alpha-Methylstyrene	330	1
Phenol	359	14
Acetophenone	396	1
		100

Phenol, acetone, and acetophenone are of commercial importance and are separated individually. Alpha-methylstyrene has uses in plastics manufacture and in some cases is separated. In the process described here it is converted to cumene.

The crude phenol is pumped to a fractionating column which operates at atmospheric pressure. Acetone is separated as overhead product. The bottoms stream passes to the cumene tower. This tower operates under vacuum and removes cumene and alpha-methylstyrene as overhead product. These materials are recycled to the hydrogenator. At this point an additional fractionator may be employed for the purpose of separating alpha-methylstyrene.

The bottoms stream from the cumene tower contains about six percent acetophenone and the remainder essentially phenol. This material passes to the phenol tower, which also operates under vacuum. The product phenol passing overhead is condensed at about 120 F. and crystallized in a special receiver. The bottoms stream contains about 15 percent phenol and the remainder acetophenone.

The importance of this process is that it provides substitution on an aromatic ring without chlorinating or sulfonating. Thus chlorine and sulfuric acid, both of which are at times in short supply, are not needed. A very small amount of sulfuric acid is used as catalyst, as mentioned above, and other acids, such as phosphoric, may be substituted for it.

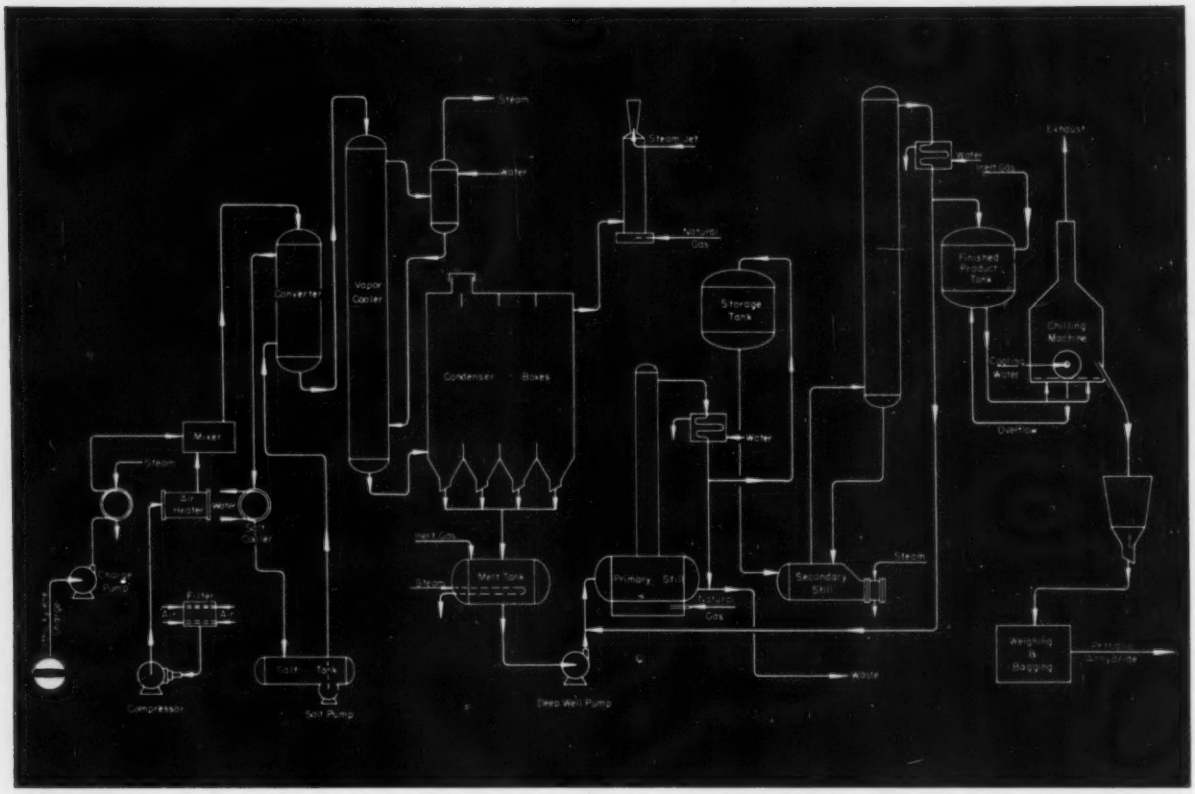
Another important feature of this process is that substantial quantities of acetone are produced. The credit for this valuable by-product strongly influences the economics of the process.

Operating Conditions: The principal conditions for the oxidation and cleavage steps are given in the above text.

Yields: The over-all process yield, from raw material cumene to finished phenol, is about 93 percent of theory.

Commercial Installations: British American-Shawinigan, Ltd., Montreal East, Canada; Barrett Division of Allied Chemical and Dye Corporation; Frankfort, Pa.; Hercules Powder Company, Gibbstown, N. J.; Oronite Chemical Company, Richmond, Calif.

Reference: PETROLEUM REFINER, Aug.'53,p123.



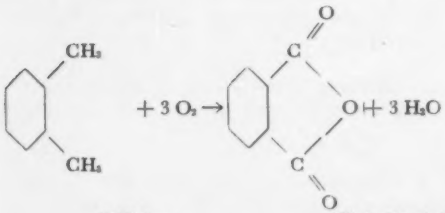
Phthalic Anhydride—CALIFORNIA RESEARCH CORPORATION

Application: This process is applied to the manufacture of phthalic anhydride.

Charge: The charge is ortho-xylene.

Product: The product is solid phthalic anhydride.

Description: The liquid ortho-xylene feed is pumped at controlled rates into vaporizers. The vaporized xylene is fed to a mixer where it is contacted with heated air. This mixture then goes to salt-cooled converter units where the following reaction occurs:



O-Xylene Phthalic Anhydride

This direct oxidation of the xylene to phthalic anhydride is promoted by the catalyst in the converter tubes which is based on vanadium pentoxide (V_3O_5). This catalyst must be carefully prepared for proper catalyst activity.

The reaction gases leaving the bottom of the converters are cooled to condense crude phthalic anhydride. The spent gases pass into catalytic incinerating furnaces to eliminate fume nuisance.

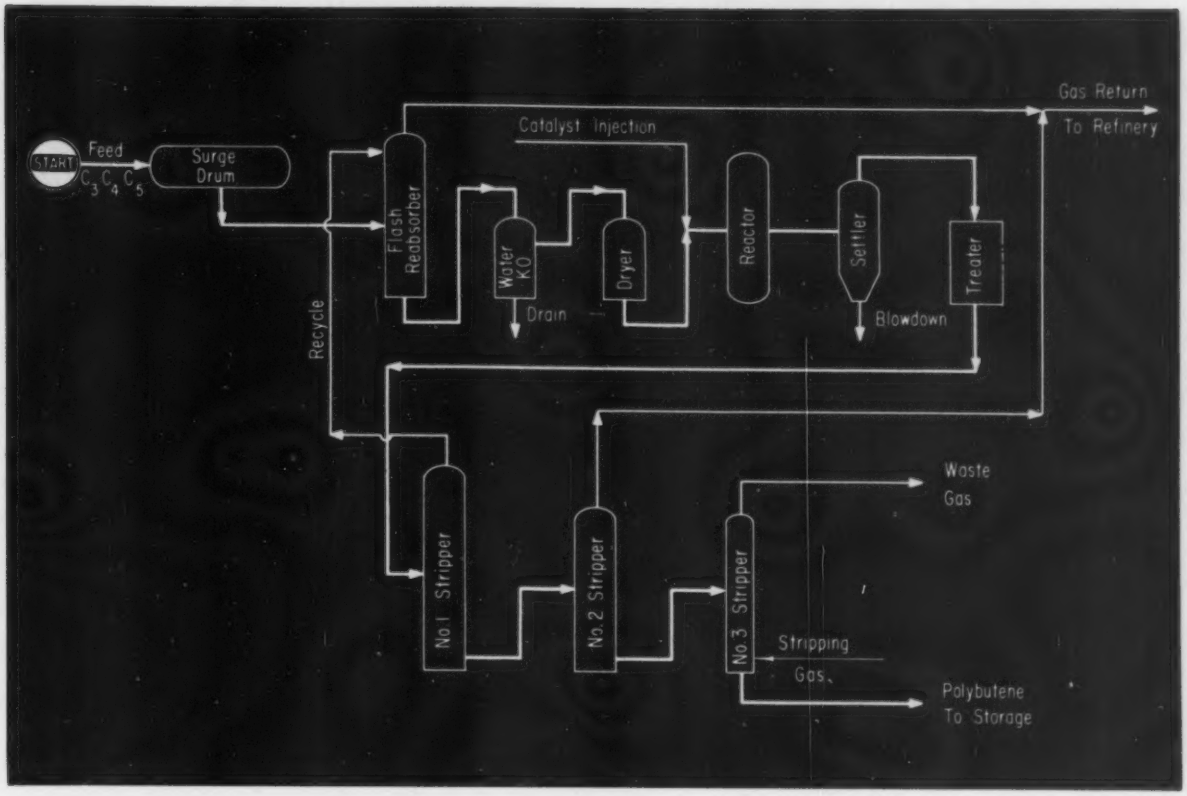
The crude phthalic anhydride goes to melt tanks for storage. The molten anhydride is distilled batchwise in two distillation stills in series. Light boilers such as benzoic acid are taken off under vacuum as a heads cut. The purified phthalic anhydride is removed as a heart cut from the second still which also operates under vacuum. The product goes from the secondary still to an aluminum storage tank. From this tank it is fed to a stainless-steel water-cooled surface for solidification. The final product in the form of chips is weighed and packed in paper bags. Molten anhydride also is shipped in steam-heated tank cars.

Operating Conditions: The most important operating conditions are the air/hydrocarbon ratio, the temperature in the converter and the contact time. Typical operating ranges for these variables are given below:

Air/Hydrocarbon Ratio	18-20
Temperature, F.	900-1150
Contact Time, Seconds	0.1-0.15

Commercial Installation: Oronite Chemical Company, Richmond, Calif.

Reference: PETROLEUM REFINER, Oct.'53,p113; *Chemical Engineering Progress,* Apr.'47,p167.



Polybutene—COSDEN PETROLEUM CORPORATION

Application: Processes for manufacturing liquid polybutene (polyisobutylene).

Charge: Refinery gas stream from catalytic and thermal cracking, including C_3's, C_4's and C_5's.

Product: Clear, viscous liquid polybutene from 500 to 1500 molecular weight and from 100 to 20,000 SSU viscosity.

Description: Polybutenes are polymerized butylenes of varying molecular weight and viscosity.

Raw material for the process consists of light hydrocarbons from refinery cracking plants and consisting primarily of the butane-butylene fractions, but including small quantities of materials in the C_3 and C_5 ranges.

The reactor feed is a combination of fresh feed and butylene recycle. This feed is first dried and then precooled with reactor effluent. Immediately before entering the reactor a slurry of anhydrous $AlCl_3$ and light polymer is injected, along with gaseous HCl activator, into the feed stream.

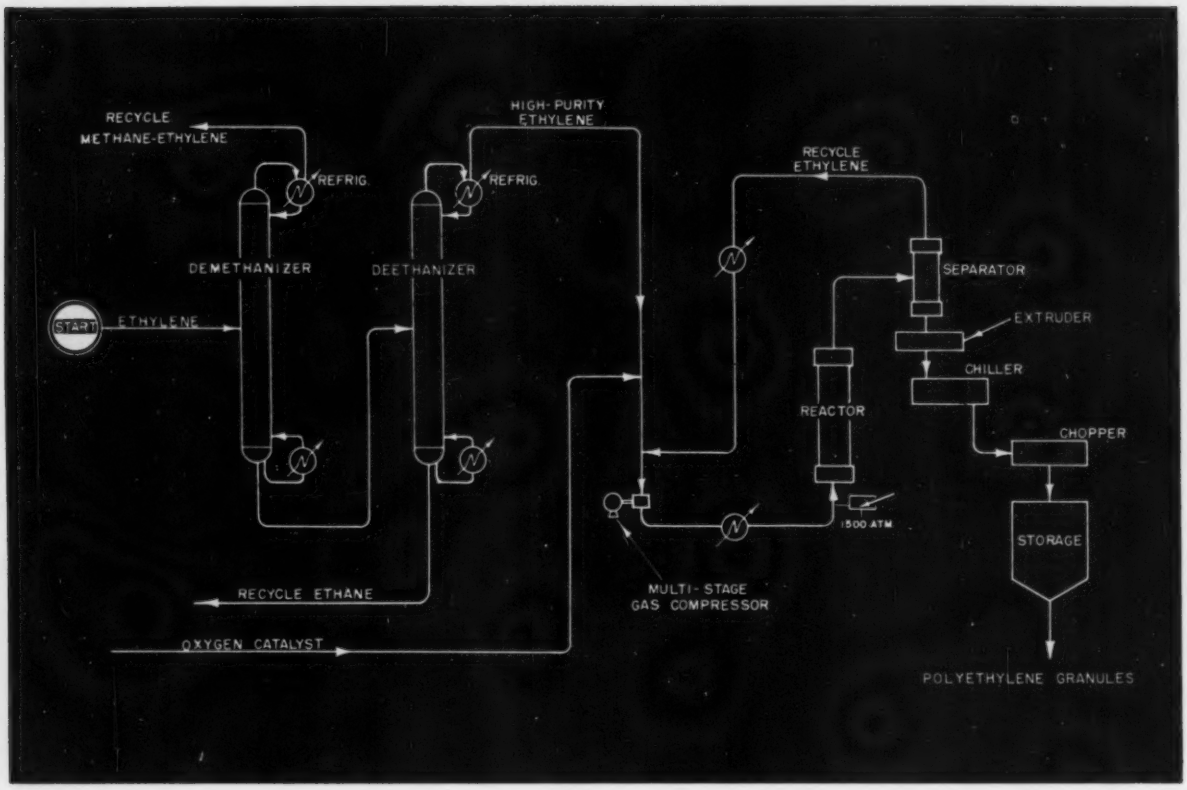
The exothermic polymerization reaction begins to take place immediately and heat is removed by an ammonia-cooled refrigeration bundle.

Temperature is a major control for viscosity and molecular weight with high molecular weight polymers forming at low temperatures and decreasing molecular weights as the temperature is increased.

Effluent from the reactor enters a settler to concentrate the suspended catalyst and return it to the reactor. Spent catalyst is removed by periodic blowdown. The decanted effluent is treated to remove contaminants; then it is fractionated and stripped to recover the polybutene as a clear, viscous liquid with the physical qualities determined by the reactor conditions. Unreacted butylenes are recycled to the reactor feed from the purification section and excess light and heavy hydrocarbon fractions are returned to the refinery for further use.

Polybutene has a number of important industrial applications among which are: the manufacture of calking compounds, sealants, adhesives, vibration dampeners, surgical tapes, electrical insulations, and special lubricants.

Commercial Installations: Enjay Company, Bayway, N. J.; Oronite Chemical Company, Richmond, Calif.; Indoil Chemical Company, Wood River, Ill., El Dorado, Ark., and Destrehan, La.; Cosden Petroleum Corporation, Big Spring, Texas.



Polyethylene (High Pressure—ICI)

Application: A process for the continuous manufacture of polyethylene.

Charge: Ethylene gas of 90-95 percent purity.

Product: Solid polyethylene.

Description: Polyethylene manufacture requires high purity ethylene and the first step is to purify the ethylene plant product.

The first purification column is the demethanizer in which the overhead, consisting of methane-ethylene, is taken back to the ethylene plant and the bottoms to the second tower where 99.8-99.9 percent ethylene is taken overhead with the bottoms going back to the ethylene plant.

In the **mass polymerization** process, an operating pressure of about 1500 atmospheres and a temperature of about 375 F is used. A free radical yielding catalyst, such as oxygen is added to the feed and the compressed mixture is fed to the reactor. Once initiated the reaction proceeds quite rapidly with about 25 percent of the ethylene being converted to high molecular weight polymer. Special means are provided to maintain essential isothermal conditions of 375 F.

The effluent from the reactor passes to a separator vessel in which unconverted ethylene is removed and recycled to an intermediate stage of the charge gas compressor. This ethylene contains no oxygen which, though serving as catalyst or initiator, is consumed in the reaction.

The liquid from the separator is water-white polyethylene with a viscosity about that of molasses. It is extruded in a form which can be quickly chilled and solidified, such as a continuous ribbon. Final steps in the process are chopping, bin storage, sacking and shipping.

In the **solvent polymerization** process, an operating pressure of about 1000 atmospheres is used. An aromatic hydrocarbon is added as a solvent to improve polymer solubility in the reaction zone and thus permit easier and quicker removal of the formed polymer before it is attacked by growing polymer chains which can result in cross-linking. A mixture of fresh and recycle ethylene, plus about 20 ppm oxygen catalyst, is dissolved in a benzene-water mixture at 375 F. The major constituents in the charge have a weight ratio of about 1.0:1.0:1.5 ethylene:benzene:water. The water contains 100 ppm of oxygen. The charge is fed to a stainless-steel tubular reactor and during the course of reaction additional water is injected to maintain a more constant catalyst concentration throughout the reactor. About 17 percent of the ethylene is converted to polymer. Isothermal conditions of 375 F. are maintained. The effluent from the reactor passes to a separator where the unconverted ethylene is removed and recycled as in the mass process. The liquid, consisting of polymer, benzene, and water is sent to a distillation unit where benzene and water are ultimately separated from the heavier polymer.

In the **water-solvent** process, water carrying additional initiator is injected at multiple points along the reaction tube in order to attain a higher conversion of the ethylene per pass through the reactor. The "half-life" of these initiators normally used is low and consequently it is necessary to continually add initiator to hold up the rate of polymer formation.

The separated polymer is handled as described above for mass-polymerized ethylene.

The product polymer has a molecular weight of 18,000-30,000.

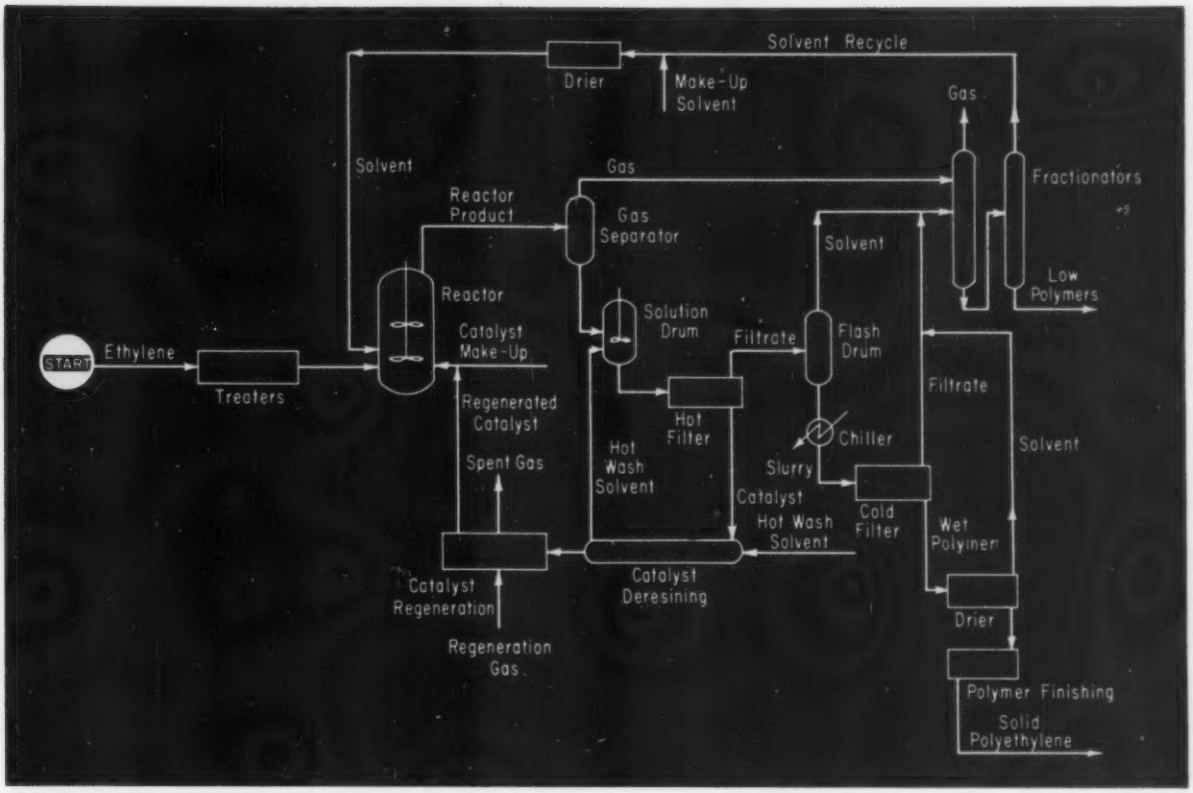
The typical processes described above are subject to variations imposed by the particular properties of polymer desired and the research findings of individual producers. Operating pressures range from 1000 to 2000 atmospheres. Tubular-type autoclave reactors may be used. Free radical generating catalysts which may be used, in addition to oxygen, would include organic peroxides such as benzoyl peroxides and di-tertiary butyl peroxide. Azo compounds and metal alkyls are also effective.

Operating Conditions: The major operating variables in the polymerization reaction are temperature, pressure, and catalyst concentration. Typical values of these variables are given in the above text.

Yields: The over-all process yield of polyethylene from ethylene is about 95 percent.

Commercial Installations: Union Carbide Chemical Company, Charleston, W. Va.; Texas City, Texas; Seadrift, Texas; Torrance, Calif. E. I. du Pont de Nemours & Company, Orange, Texas. Canadian Industries, Ltd., Edmonton, Canada. Spencer Chemical Company, Orange, Texas. The Dow Chemical Company, Freeport, Texas. Texas Eastman Company, Longview, Texas. Monsanto Chemical Company, Texas City, Texas. National Petrochemical Corp., Tuscola, Ill. and Koppers Co., Inc., Port Arthur, Texas.

Reference: "The Chemistry of Petrochemical Reactions," Lewis F. Hatch. "Polythene," A. Renfrew and Phillip Morgan.



Polyethylene (Low Pressure—Slurry-Solution Process)

Application: A relatively low-pressure process for the continuous production of polyethylene.

Charge: Ethylene gas of 95 percent purity.

Product: Solid polyethylene.

Description: This is a process in which the solid catalyst and solvent are present in the reactor as a slurry, and the polymer is maintained in solution until after the catalyst is removed from the reaction mixture.

The ethylene charge gas, free of sulfur compounds, is treated for removal of catalyst poisons such as water, oxygen and carbon dioxide. Conventional treating may be employed, such as hot metallic copper for oxygen, anhydrous calcium sulfate or alumina for water and supported caustic for carbon dioxide.

The treated ethylene and a suitable hydrocarbon solvent are charged to the reactor at rates to give the equivalent of around 5 weight percent ethylene. A suitable catalyst, such as hexavalent chromium oxide (Cr_2O_3) on a silica-alumina support, is maintained at a concentration of 0.5 percent or less (based on weight of solvent). The solvent may be a C_5 to C_8 paraffin, a naphthene or an aromatic such as toluene or xylene. The aromatics have higher solvency toward polyethylene than the other solvents. The solvent serves several functions in addition to its role as a solvent for ethylene and polyethylene. It protects the growing polymer chain from chain-breakers, controls the viscosity of the solution, controls the rate of ethylene consumption to promote good polymer growth, and it serves as a medium for dissipating the heat of reaction. The reactor is maintained at a temperature of 200 to 300 F. and a pressure in the range of 100 to 500 psig.

The reactor product is sent to a gas separator and then to a solution drum where additional hot solvent from the deresining operation is added to insure that all of the polymer is in solution. The mixture is then filtered to remove the catalyst which is sent to a deresining chamber where residual polyethylene is recovered from the catalyst. The spent catalyst is regenerated and returned to the reactor.

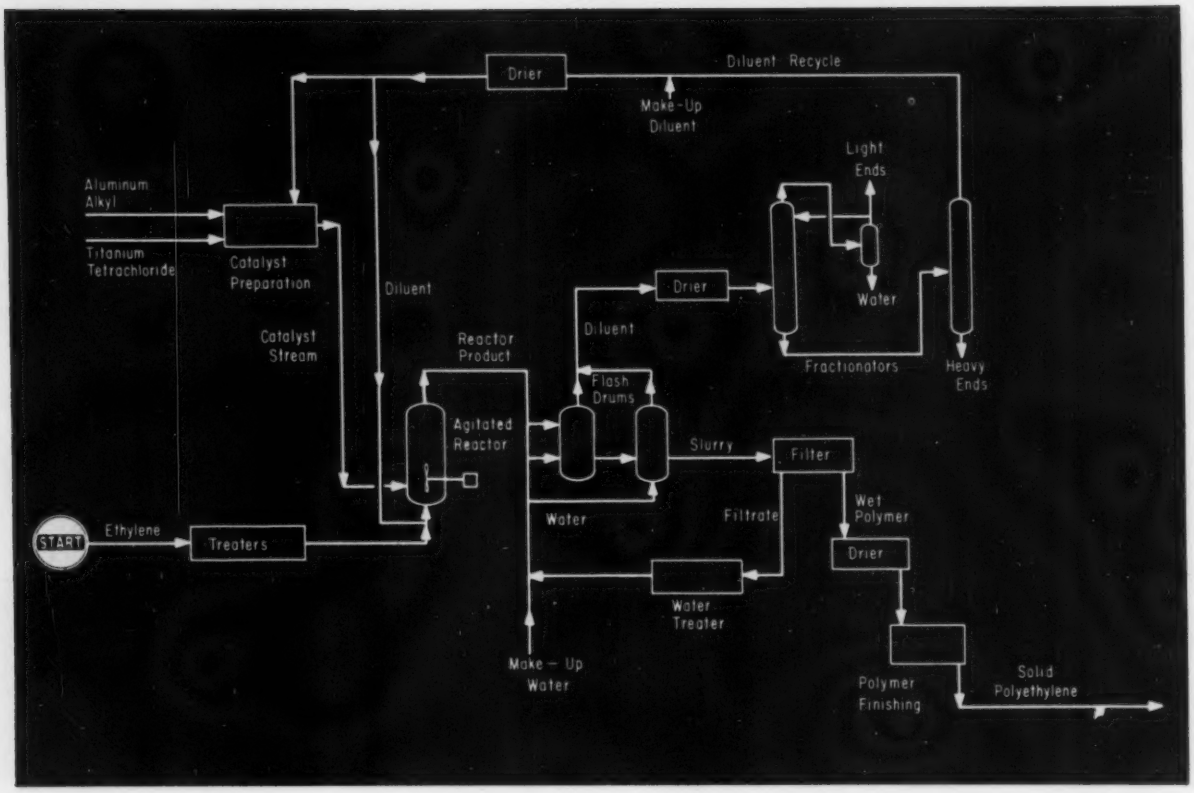
The hot filtrate is sent to a flash drum for removal of some of the solvent and then to a chiller where the temperature is reduced to 75 to 150 F. The increased polymer concentration and temperature reduction causes the high molecular weight polymer to precipitate as a solid and form a slurry. Anti-solvents, such as propane, alcohols or water may be employed at this step to facilitate separation of the polymer from the solvent. The slurry is filtered to recover an essentially ash-free polymer which is dried and finished as polyethylene pellets. The filtrate and flashed solvent streams are combined and sent to fractionators, along with the separator gas, for solvent recovery and purge of inert gas and low polymers. The solvent is combined with make-up solvent, dried and sent to the reactor.

Operating Conditions: The ranges of the principal operating conditions are given in the foregoing description. They are influenced largely by the properties of the solvent employed.

Yields: The conversion of ethylene to polymer is virtually 100 percent, and recovery of solid polymer is in excess of 98 percent.

Commercial Installation: The Phillips Petroleum Company, W. R. Grace and Company and Celanese Corporation of America have plants utilizing variations of the principles described here.

Reference: PETROLEUM REFINER, Aug.'55,p111.



Polyethylene and Polypropylene (Low Pressure—Ziegler)

Application: A low pressure process for the continuous production of polyethylene (or polypropylene).

Charge: Ethylene gas of 95 percent purity for polyethylene. (Propylene of similar purity for polypropylene.)

Product: Solid polyethylene (or polypropylene).

Description: The accompanying flowsheet describes the principles of the low pressure polyethylene process that employs Ziegler catalysts. Many details of the process are still confidential, especially those related to catalyst preparation and to catalyst and ash removal after the polymer is formed. Numerous catalyst combinations are possible; however, the popular combination consists of aluminum triethyl, which promotes the polymerization, and titanium tetrachloride, which in combination with aluminum triethyl forms a finely divided precipitate which catalyzes the anionic polymerization. The catalyst constituents are extremely reactive to water and oxygen; therefore, since only a trace of catalyst is required, it is carried in a carefully dried diluent under conditions that make it safe to handle.

The ethylene charge gas is treated for removal of sulfur compounds, oxygen, water and carbon dioxide, and is then charged to the reactor. The diluent may be a C_5 to C_7 paraffin or naphthene or one of the lower aromatics. The catalyst is charged as a very dilute stream. The reactor is maintained at a pressure in the range of one atmosphere to 100 psig and a temperature of 140 to 170F.

The reactor product is sent to a series of flash drums to remove the diluent. These drums are maintained at conditions in the range of 3 to 5 psig and the appropriate temperature to flash the diluent. Water is added to the flash drums to destroy the catalyst and slurry the polymer. The diluent is sent to a drier to remove entrained water and then charged to a fractionator where light ends and water are removed as an azetrope. The bottoms is sent to a second fractionator for removal of heavy ends, and the diluent is recovered for recycle.

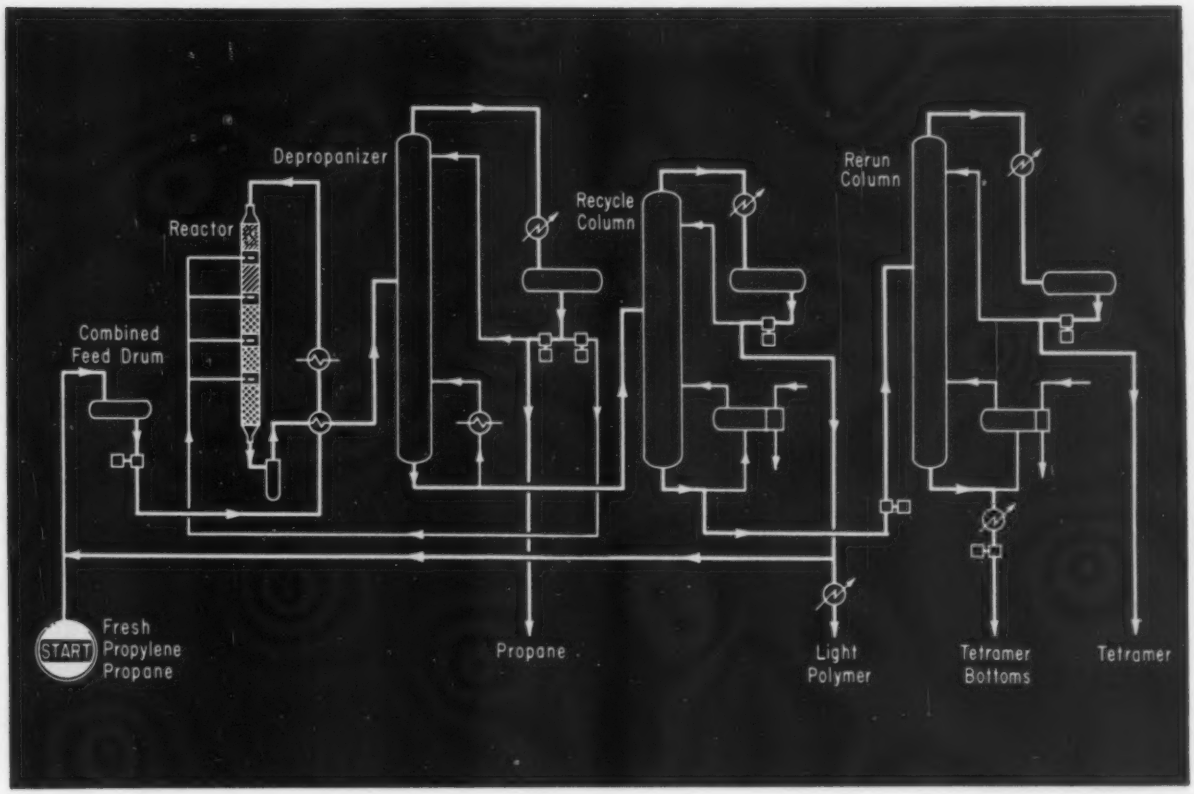
The water-polyethylene slurry is filtered, and the aqueous filtrate is treated and recycled to the flash drums. Alcohol may be used in place of water to destroy the catalyst and wash it from the polymer. Additional filtration steps and special treating agents may be employed to help remove the catalyst. The solid polyethylene is dried, extruded and finished to form polyethylene pellets.

Operating Conditions: The operating conditions given above are influenced by the physical properties of the diluent.

Yields: The over-all yield of polymer is around 95-98 percent of the ethylene consumed.

Polypropylene: This polymer is made from propylene in essentially the same process and under nearly the same conditions except that titanium trichloride is used in place of titanium tetrachloride. This increases the yield of polymer to over 90 percent based on the olefin charged.

Commercial Installations: At least nine U. S. companies are testing the Ziegler process for polyethylene manufacture. Union Carbide Chemicals Company, du Pont, Hercules, and Koppers have already offered at least limited commercial samples or announced plans for commercial production.



Propylene Tetramer—UNIVERSAL OIL PRODUCTS COMPANY

Application: A process used to manufacture specialty polymers from propylene, such as tetramer.

Charge: Propane-propylene cut, commonly derived as a by-product from certain petroleum refinery operations.

Product: C_9 polymers (trimer), C_{12} polymers (tetramer), C_{15} and higher polymers (pentamer), light motor polymer, and propane.

Process Description: The feed stock usually available may contain such undesirable impurities as hydrogen sulfide and basic nitrogen compounds. Purification is desirable before charging to the reactor section.

Caustic washing is generally used to remove sulfur compounds. Subsequent scrubbing with water will remove basic nitrogen compounds. A settling chamber, which may also serve as a feed surge drum, follows the washing steps to remove entrained water.

The purified feed is mixed in the feed surge drum with a recycle stream of light polymer. This mixture is heated by exchange with reactor product and then brought to reaction temperature with steam, for example, and then charged to one or more reactors in parallel. The reactor section contains multiple fixed beds of solid phosphoric acid. The reaction temperature is controlled by inter-bed quench with a propane stream.

The reactor effluent passes to a depropanizer in which residual propane is separated. Part of this is used as a quench stream to the reactor, the balance constituting a net stream of LPG. The depropanizer bottoms stream passes to one or more fractionating columns for separation of the total polymer into fractions of various boiling range.

Two polymer fractionators are shown in the schematic flow diagram. The first (recycle column) removes as overhead distillate the light polymer boiling up to the initial boiling point of the tetramer product. This light polymer is used principally for recycle to the combined feed drum for further polymerization; the balance may be withdrawn as net light polymer product.

The crude tetramer bottoms stream from the recycle column then enters the tetramer rerun column. Specification product is removed as an overhead stream, a small amount of heavy polymer being rejected as bottoms product.

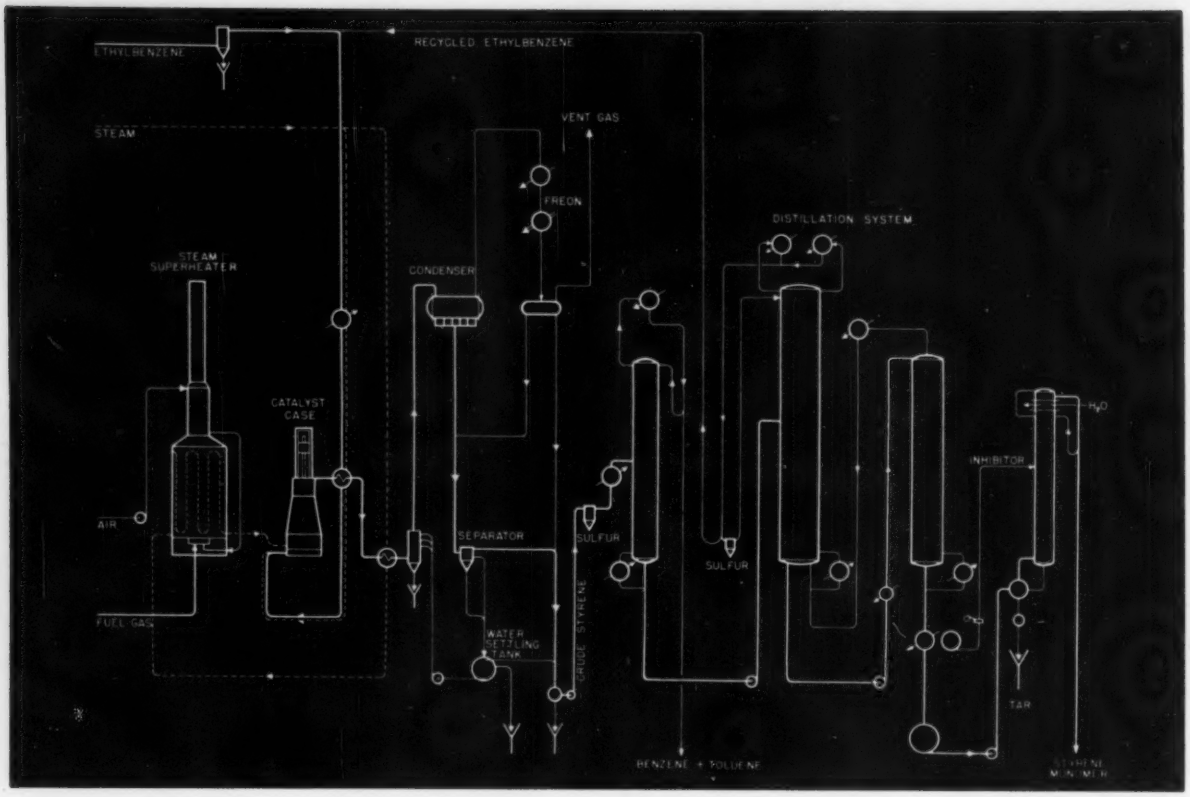
At least one additional fractionating column is required when making trimer. The complexity of fractionation is determined by the specifications to be met by the ultimate trimer product.

Pentamer can be produced by modifying the process conditions in a plant basically designed for tetramer production.

Yields: Characteristic yields for the tetramer operation are:

Fresh Feed	Vol. Percent	Products	Vol. Percent
Propylene	49.3	Tetramer 350-480 F.	29.1
Propane	50.7	Heavy Polymer 480 F.-EP	1.3
		Light Polymer IBP-350 F.	0.3
		Propane LPG	54.6

Commercial Utilization: The first of the specialty polymers of commercial interest was propylene tetramer, now widely employed in manufacturing the sulfonated dodecylbenzene type of synthetic detergents. Propylene trimer has become important more recently, being used as a raw material in the synthesis of nonylphenol and decyl alcohol. Higher boiling specialty polymers, such as the pentamer, are becoming increasingly popular as starting materials in the production of other controlled-property detergents.



Styrene

Application: This process is applied to the manufacture of styrene monomer by the catalytic dehydrogenation of ethylbenzene.

Charge: The charge is ethylbenzene.

Product: High purity styrene monomer is the product.

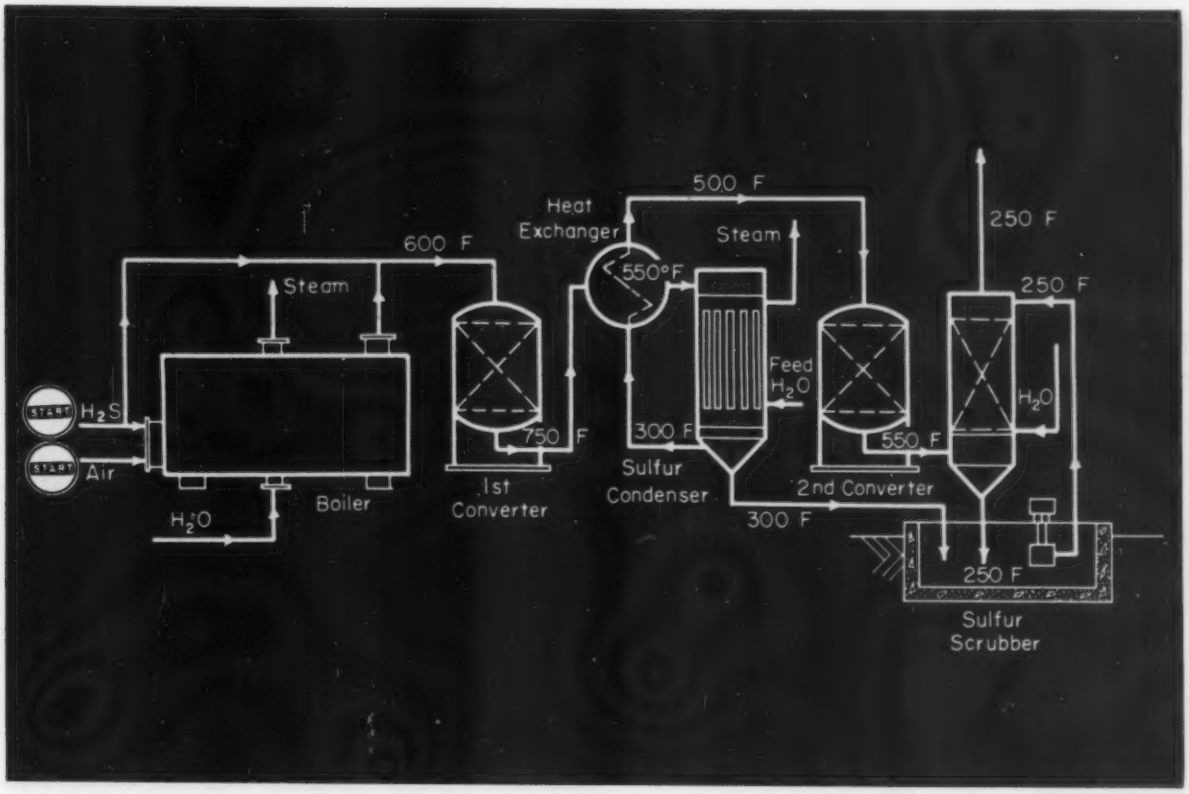
Description: Since reduced pressure favors the dehydrogenation reaction, steam is fed at a rate of 2.6 pounds per pound of ethylbenzene. About 90 percent of this steam is heated to about 725 F. before entering the superheating furnace which produces steam at 1310 F. The other 10 percent of the steam is mixed with ethylbenzene and passed through a vaporizer, being heated to 320 F. before heat exchange with hot reactor product. Ethylbenzene vapors at 970 F. are mixed with steam at 1310 F. in the reactor. The resulting temperature at the bottom of the catalyst bed is 1166 F. This temperature is the control point for the reaction system. Reactor product at 1049 F. is cooled by heat exchange, first with incoming ethylbenzene, and then with steam. From this point a spray-type desuperheater lowers the crude product temperature to 221 F. and condenses tars formed at high temperatures. Vapors then enter the final condenser, where steam, styrene, ethylbenzene, benzene, toluene, and small amounts of tar are liquefied. Vent gases containing hydrogen, carbon monoxide, carbon dioxide, methane, ethane, plus some of the aromatics pass overhead to a refrigerated recovery system.

The final step is the purification of the crude dehydrogenated material containing about 37 percent styrene. Styrene polymerization difficulties can be avoided by distilling inhibited styrene in a system which never allows the concentrated monomer to exceed 194 F. Crude styrene passes through a pot containing sulfur. Enough sulfur is dissolved to act as a polymerization inhibitor. After preheating, the feed enters the 30-plate benzene-toluene column where benzene and toluene pass overhead at 135 F. The top of this column operates at 175 mm Hg., and reflux ratio of 12 to 1 is employed. Since styrene is still diluted with ethylbenzene and tar, a temperature of 205 F. is allowable at the bottom. Sulfur passes down the column and effectively inhibits the stripping zone.

Ethylbenzene, styrene and tar are fed to the primary ethylbenzene column. To overcome the difficulties of excessively high temperature on the bottom and excessive pressure drop, the separation of ethylbenzene and styrene is effected in two steps. The primary ethylbenzene column acts as the top 38 plates and the secondary ethylbenzene column acts as the bottom 32 plates. Vacuum jets and cooling water keep the top of each at 35 mm Hg. so that bottom temperatures can be held at a safe level of 194 F.

The overhead of the primary column is ethylbenzene containing about 1 percent styrene which is recycled back to dehydrogenation feed. The bottom stream is fed to the secondary column where styrene and tar are taken out the bottom and fed to a packed batch styrene finishing still operating a 35 mm Hg. pressure. Tar and sulfur are removed in this still. An inhibitor, tertiary butyl catechol, is added to the styrene in the concentration of 10 ppm before shipment of the styrene product.

Yields. Conversion of ethylbenzene to styrene is about 37 percent per pass. Over-all yield amounts to about 90 percent.



Sulfur Recovery— THE GIRDLER COMPANY

Application: The process is applied to the recovery of elemental sulfur from hydrogen-sulfide bearing gases.

Charge: Although the acid gas stream from a Girbotol plant is an ideal feed material, almost any hydrogen sulfide or hydrogen sulfide and carbon dioxide gas mixture may be employed.

Product: The quality of the sulfur is equal to or better than bright Gulf Coast sulfur.

Description: The process is based on a modification of the original Claus process for carrying out the highly exothermic reaction:

$$H_2S + 1/2O_2 \rightarrow S + H_2O$$

In order to remove the heat generated more efficiently and maintain better control over the process the above reaction is carried out in two steps as follows:

$$(1)\ H_2S + 3/2O_2 \rightarrow SO_2 + H_2O$$

$$(2)\ 2H_2S + SO_2 \rightarrow 3S + 2H_2O$$

The accompanying flow plan is typical of a two stage plant and shows the approximate temperatures for a feed gas containing about 90 percent hydrogen sulfide. Reaction (1) takes place in the combustion chamber of a fire-tube boiler where approximately one-third of the hydrogen sulfide is burned to sulfur dioxide.

Following the steam boiler the gases pass through the first converter where most of reaction (2) takes place and a gas temperature rise results. It is estimated that 70-80 percent of the sulfur recovered is formed in the first stage and the balance in the second after intermediate product removal. The catalyst employed is activated bauxite which has an indefinite life, being subject only to mechanical failure.

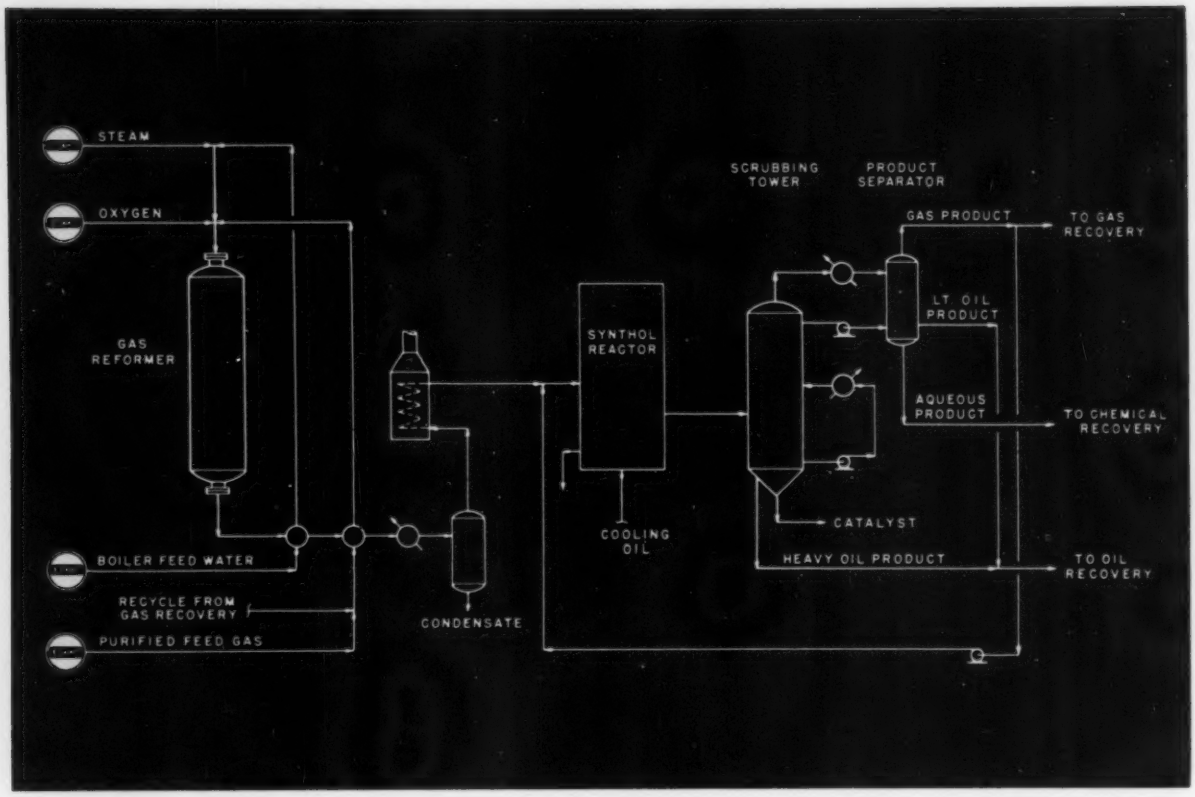
In order to remove the sulfur formed in the first converter the gases are cooled to approximately 300 F. and the sulfur condensed. The gases are reheated before entering the second converter. Final cooling and condensation after the second converter take place in a carbon steel, Raschig ring packed scrubber where the hot gases pass countercurrent to liquid sulfur. The circulating sulfur, heated in the scrubber, returns to the sulfur tank carrying with it the newly formed sulfur. The tail gases largely consist of nitrogen, water vapor, carbon dioxide (if present originally), and small percentages of unreacted hydrogen sulfide and sulfur dioxide.

Yields: Generally a minimum of 90 percent of the sulfur present in the hydrogen sulfide may be recovered in a two-stage plant, and up to 95 percent recovery is readily attained in commercial practice. However, a single-stage plant, designed to recover 80-85 percent of the hydrogen sulfide as sulfur, may prove more economical for smaller capacity installations.

Commercial Installations: Companies using this process are: Freeport Sulfur Co., Stanolind Oil and Gas Co., Standard Oil Co., (New Jersey), Union Oil Co., and General Chemical Division of Allied Chemical & Dye Co. A plant is being engineered for Idemitsa Kosan Co., Ltd.

Reference: *Petroleum Processing*, Sept. 1954,p1404.

The Girdler Co. is a division of National Cylinder Gas Co.



Synthol Process—THE M. W. KELLOGG COMPANY

Application: A process for the synthesis of hydrocarbons and oxygenated chemicals from hydrogen and carbon monoxide.

Charge: Purified synthesis gas having a hydrogen to carbon monoxide ratio of 2.0 to 2.8.

Product: High olefin content hydrocarbons within the boiling point range of gasoline through heavy fuel oil as well as a wide range of oxygenated chemicals. The following is typical of the products produced from one type of recovery: LPG (50-100 psia vapor pressure), motor gasoline (85-90 CFRR clear), diesel oil, fuel oil, methanol, ethanol, methyl ethyl ketone, and acetone. Both water soluble and oil soluble organic acids may also be recovered.

Description: The feed gas is a mixture of hydrogen, carbon monoxide and carbon dioxide plus light hydrocarbons. This gas should be treated for the removal of sulfur compounds and resins if present. The purified feed enters the Gas Reforming Unit where it is mixed with recycle tail gas from the recovery units and preheated by suitable heat exchange with the reformer effluent. Steam is then added to this mixture and the total stream is fed to the reforming chamber where it is mixed with essentially pure oxygen. Partial oxidation and reforming of the gas takes place over the catalyst in the reformer chamber at temperatures in the range of 1600 F.-2200 F. and pressures in the order of 350 psig. The gases are then heat exchanged to generate almost all of the steam required for the feed and further exchanged and cooled to remove the water vapor. The reformed gas consists primarily of hydrogen and carbon monoxide and is fed to the Synthol Unit.

The synthesis reactor feed is preheated in a furnace and mixed with recycle gas. It then enters the reactor where it mixes with hot circulating catalyst.

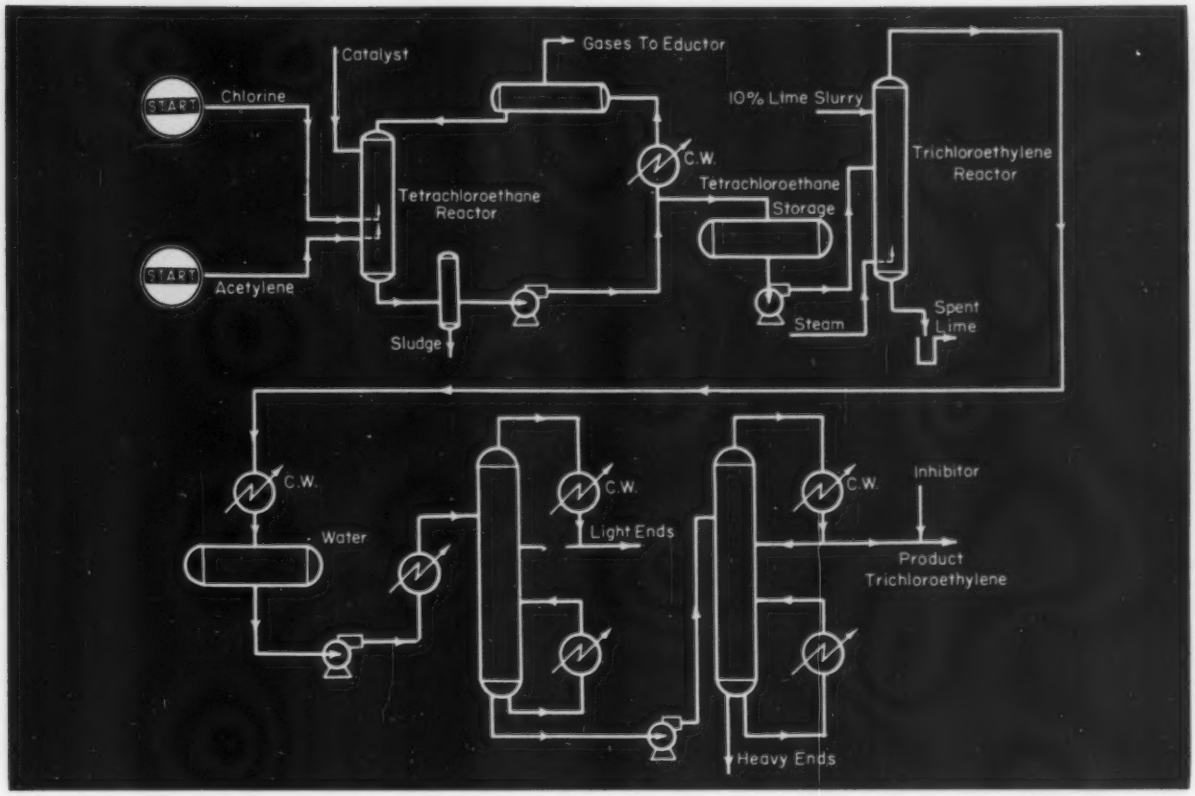
Reaction temperatures are in the range of 590 F.-650 F. and pressure is in the range of 250-350 psig. The reacted gases pass through settling section where the bulk of the catalyst is removed and on to the scrubber tower. In this tower the reactor effluent is quenched and the remaining catalyst is scrubbed from the gas. The heavy oil product and catalyst are removed from the bottom of this tower and the other oil and chemical products pass overhead. The heat removal is by intermediate and top tower reflux. The overhead is cooled and condensed to yield the light oil and aqueous product liquids and the gas product, which is divided into recycle and net gas product.

The gas product passes on to recovery where the hydrocarbons are removed for conversion to polymer gasoline. The light and heavy oil products are processed to produce gasoline and the other products shown above. The aqueous product is processed for recovery of the pure chemicals noted above.

Yields: Conversions of carbon monoxide in the synthesis reactor are 95 percent-98 percent. Overall carbon utilization from purified feed gas to useful products can be maintained at about 88 percent through recycle of unconverted gases regardless of conversion level. If the carbon dioxide, which must be scrubbed from the gas returning to the Reforming Unit can be utilized, this over-all figure is several percent higher.

Commercial Installations: This process is being employed in the South African Coal, Oil and Gas Corp. plant in the Union of South Africa.

Reference: PETROLEUM REFINER, Dec.,'56,p222.



Trichloroethylene

Application: A process for the manufacture of trichloroethylene.

Charge: Acetylene, 99 percent purity; chlorine, 99+ percent purity.

Product: Stabilized trichloroethylene, 99+ percent purity.

Description: The commercial manufacture of trichloroethylene from acetylene and chlorine consists of two main process steps: production of the intermediate tetrachloroethane and production-purification of the final product Trichloroethylene.

Acetylene and chlorine are combined in a liquid-phase, catalytic reaction to produce tetrachloroethane. The reactor is a steel tower through which a large recycle stream of tetrachloroethane reaction product is circulated. The exothermic heat of reaction is removed in an exchanger located in the circulating system.

Typical operating conditions for the reactor are: top temperature, 160 F.; bottom temperature, 195 F.; pressure, 0-5 psig; chlorine: acetylene molar feed ratio, 2.00-2.05. A catalyst such as antimony trichloride or ferric chloride is used in about 0.1 wt-percent concentration. Small amounts of hydrogen chloride and other noncondensibles are removed from the circulating system by an eductor. Other by-products include dichloroethylene and hexachloroethane, the amounts depending on the ratio of primary reactants.

Tetrachloroethane is pumped from intermediate storage to the trichloroethylene reaction tower where it is contacted with a 10 percent lime slurry. Dehydrochlorination takes place according to the reaction.

$$CHCl_2 \cdot CHCl_2 + \tfrac{1}{2}\, Ca(OH)_2 \rightarrow CHCl{:}CHCl_2 + \tfrac{1}{2}\, CaCl_2 + H_2O$$

The reactor is a steel tower filled with packing or trays, and operates at atmospheric pressure. Tetrachloroethane is boiled up in the lower section by means of live steam. The lime slurry is fed to the top of the column, thus contacting the ascending tetrachloroethane vapors. The top temperature in the tower is about 160 F., which corresponds to a crude trichloroethylene-water azeotrope containing about 7 percent water. The bottom temperature is maintained at about 215 F. which is sufficient to exclude most of the tetrachloroethane from the spent lime leaving the bottom of the tower.

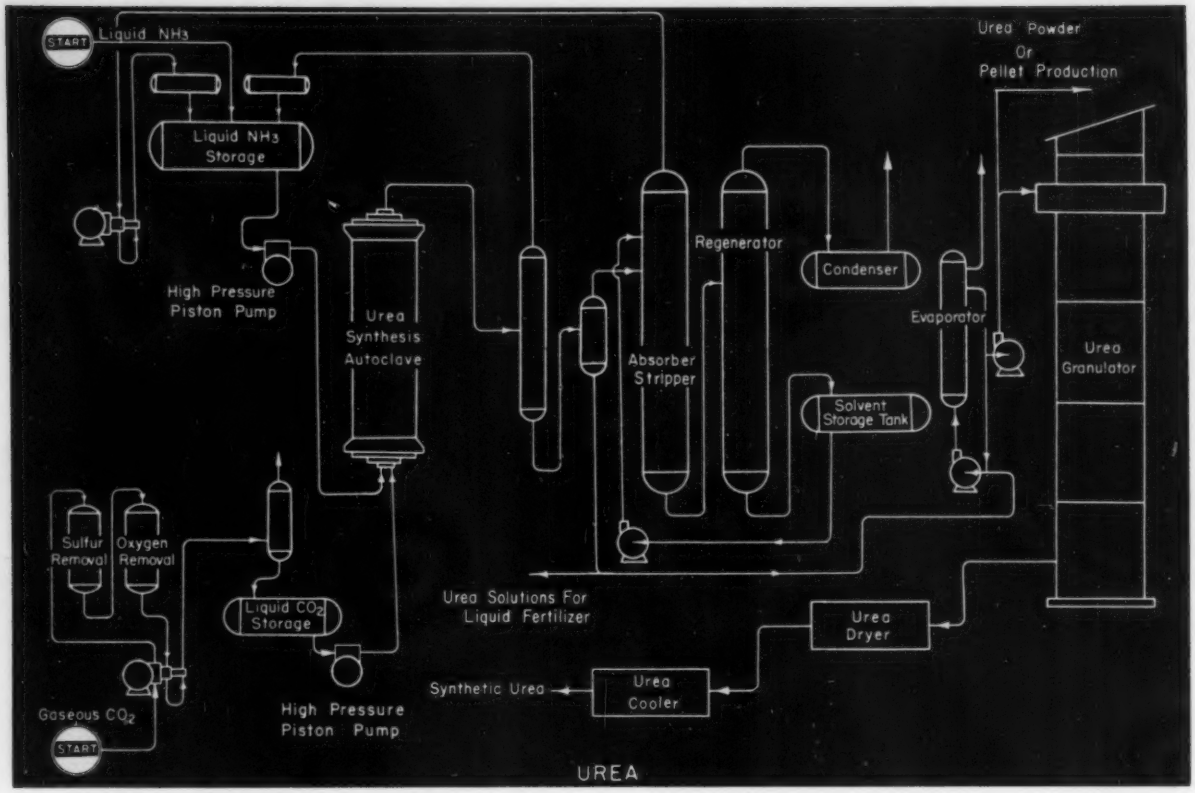
For a condition of 10 percent excess $Ca(OH)_2$, trichloroethylene is produced in 95-97 percent yield from tetrachloroethane. Conversion of tetrachloroethane is essentially complete.

The overhead stream from the reactor tower is condensed, the water separated, and the crude trichloroethylene fed to the final purification section.

Operating Conditions: Details are given in above text.

Yields: Over-all process yields, acetylene or chlorine to trichloroethylene, are on the order of 90 percent.

Commercial Installations: This process or a variation is used at the following locations: Columbia-Southern Chemical Corp., Barberton, Ohio; E. I. du Pont de Nemours and Co., Niagara Falls, N. Y. and Wyandotte, Michigan; Hooker Electrochemical Co., Ashtabula, Ohio, Niagara Falls, N. Y. and Tacoma, Wash.; Niagara Alkali Company, Niagara Falls, N. Y.



Urea—CHEMICAL CONSTRUCTION CORPORATION

Application: This process is applied to the manufacture of synthetic urea.

Charge: Carbon dioxide and liquid ammonia are the charge.

Product: The product is urea in any of the following forms: Urea solutions, spherical granules (Prills) for fertilizer and cattle feed supplement, and crystals of high purity for plastics manufacture.

Description: The urea synthesis plant shown in the flow diagram is designed to produce urea in any of the above-mentioned forms from liquid ammonia and gaseous carbon dioxide.

The gaseous carbon dioxide enters the process system where it is first compressed and then freed of sulfur and oxygen. The purified carbon dioxide is liquefied and collected in a surge tank.

Liquid ammonia and liquid carbon dioxide are fed into the urea synthesis autoclave in the ratio approximate of six moles of ammonia to one mole of carbon dioxide. In the autoclave, one mole of carbon dioxide reacts with two moles of ammonia to form ammonium carbamate which, in turn, partially dehydrates to form urea. The reaction is shown by the following equation:

$$CO_2 + 2NH_3 \rightarrow \underset{\text{Ammonium Carbamate}}{NH_2\,CONH_4\,OH} \rightarrow \underset{\text{Urea}}{NH_2\,CONH_2} + H_2O$$

At the conditions prevailing in the reactor, a molal ratio of ammonia to carbon dioxide of 6:1 and a temperature of 185 C., the conversion of ammonium carbamate is approximately 75 percent. The reaction mixture leaving the autoclave, which consists of urea, water, ammonium carbamate and ammonia, undergoes a pressure reduction and flows to the recycle ammonia separator, where most of the excess ammonia (four moles) is recovered at a pressure high enough to be condensed with the available cooling water. This liquefied ammonia is returned to the liquid ammonia storage tank.

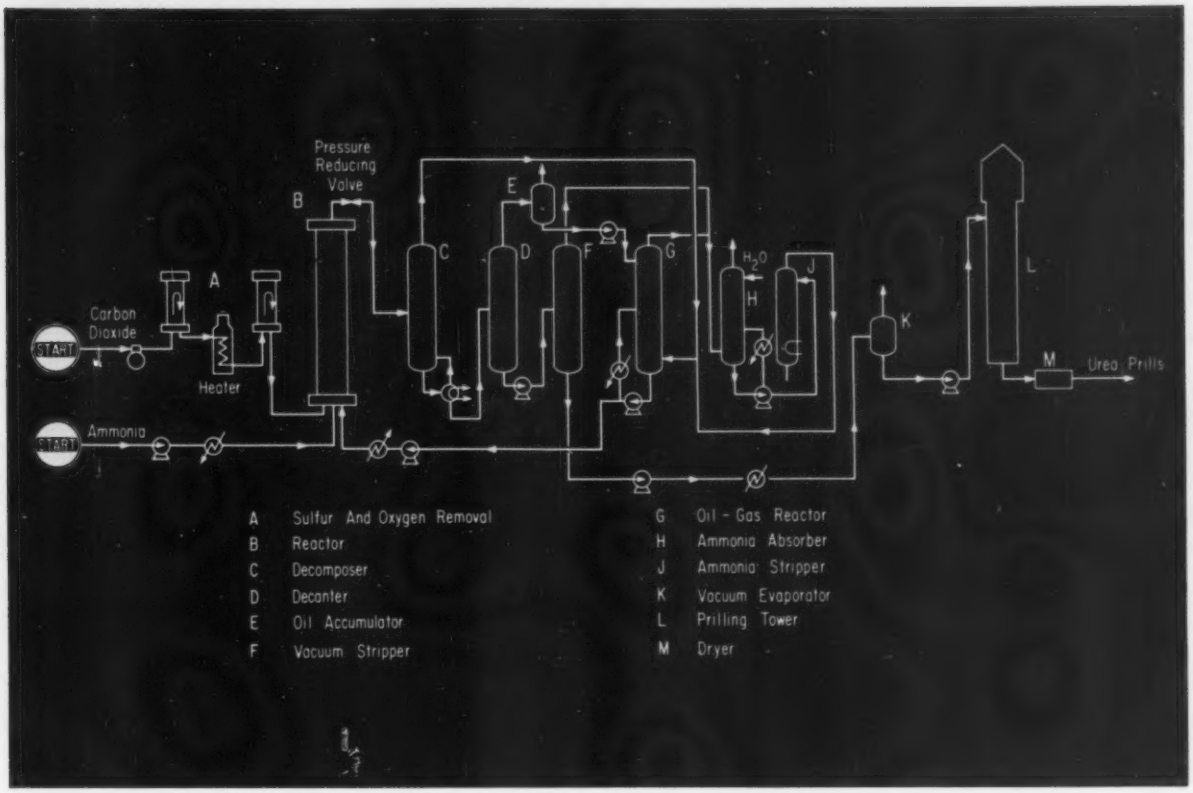
The liquid recation mixture, freed of the excess ammonia, undergoes another pressure reduction and enters the carbamate decomposer. Here, the unconverted ammonium carbamate is dissociated into the original feed materials, carbon dioxide and ammonia. The mixture of these two gases leaving the carbamate decomposer is sent to the carbon dioxide absorber stripper where a solvent absorbs the carbon dioxide from the gas mixture. This leaves a pure ammonia gas which is compressed, liquefied, and returned to the liquid ammonia storage tank. The carbonated solvent passes to the regenerator, where the solvent is regenerated by removing the absorbed carbon dioxide. The regenerated solvent is then returned to the carbon dioxide stripper.

The bottoms from the carbamate decomposer, which consists of an aqueous solution of urea, may be used directly for the production of fertilizer and cryrstals; or fed to the evaporator for the production of urea prills.

For the production of urea prills, a 99.5 percent solution is pumped from the evaporator to the urea granulator. The urea emerges in the form of spherical granules; the product is cooled before storage and bagging.

For the production of urea powder, a 90 percent solution is pumped to a powder blender and then dried. Urea pellets of a variety of sizes can be produced by extruding this powder in a pelletizing machine.

Commercial Installations: Sumitomo Chemical Co., Ltd., Niihama, Japan, and Nippon Gas Chemical Industries, Ltd. Niigata, Japan. In addition, a plant to produce 200 tons per day is now being designed for a client in North America.



Urea— FOSTER WHEELER CORPORATION

Application: A process for the manufacture of urea.

Charge: Ammonia and carbon dioxide.

Product: Prilled solid urea.

Description: Urea synthesis, in the Pechiney process, essentially is achieved by the non-catalytic reaction of ammonia and carbon dioxide at a pressure of 3000 psig. The outstanding feature of the process is the use of a neutral oil in which unconverted feed gases in the form of an ammonium carbamate slurry is recycled to the reactor. The products of the reaction are highly corrosive and the neutral oil circulating medium minimizes attack of metal parts and also moderates temperature variations in the reactor.

Carbon dioxide compressed to reaction pressure, treated to remove any residual sulfur and oxygen, is preheated and charged to the reactor. Liquid anhydrous ammonia is preheated and also enters the reactor. The recycle stream containing 35-40 percent ammonium carbamate solid in a highly dispersed slurry-in-oil also enters the reactor. The primary reaction is to form ammonium carbamate from ammonia and carbon dioxide.

This is a highly exothermic reaction and supplys the heat for the secondary reaction, the decomposition of carbamate to urea and water, which is endothermic. The oil carrier thus serves as a thermal fly wheel storing the heat liberated by the first reaction and releasing it for the second reaction.

The effluent from the reactor, viz., urea, undecomposed carbamate, water and carrier oil flows through a pressure reducing valve from the 3000 psig reactor pressure to approximately 60 psig and into the decomposer where heat is applied to decompose carbamate into ammonia and carbon dioxide.

The aqueous urea solution and oil passes to the decanter where the carrier oil settles as a top layer and flows to the oil accumulating tank. The aqueous urea solution, withdrawn from the bottom of the decanter, flows to a vacuum stripper where final traces of ammonia are removed. The urea solution is evaporated under vacuum for essentially complete removal of water.

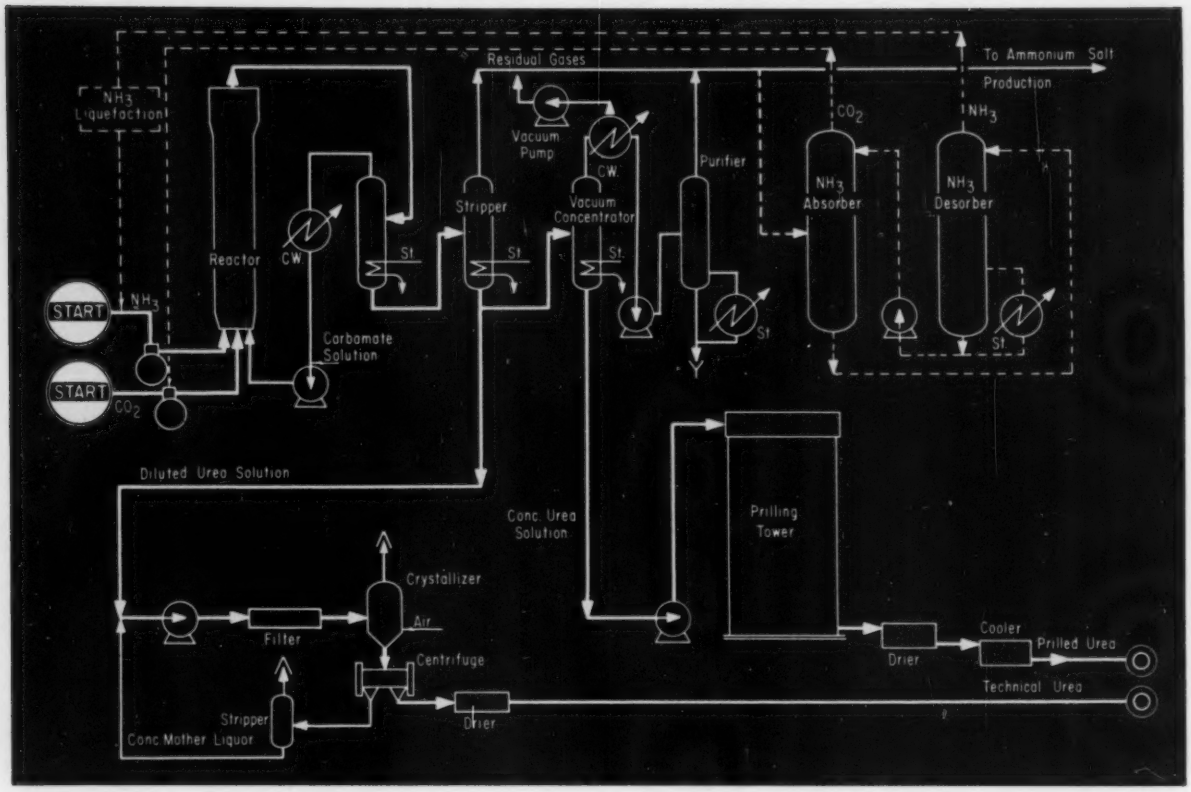
Molten urea is then pumped to the top of a prilling tower where the melt is sprayed counter-current to a rising stream of warm air which causes the urea to solidify into spherical pellets or prills. The prills are dried, cooled and transferred to storage.

Unconverted ammonia and carbon dioxide gases, from the decomposer, flow to the oil-gas reactor where they combine to form solid ammonium carbamate finely dispersed in the circulating oil. This recycle stream of ammonium carbamate and oil is pumped back to the synthesis reactor.

Vent gases, containing ammonia, from both the vacuum stripper and the oil-gas reactor are charged to a recovery system where ammonia is recovered by absorption with water.

Operating Conditions: Essential operating conditions are given in the above description.

Commercial Installations: Grand River Chemical Division of Deere and Company, Pyor, Okla. and Grace Chemical Co., Division of W. B. Grace & Co., Memphis, Tenn.



Urea—MONTECATINI

Application: A process for the manufacture of synthetic urea.

Charge: Liquid ammonia and gaseous carbon dioxide free from sulphur compounds having, at least, 97 percent purity.

Product: Fertilizer grade urea in spherical granules or technical grade urea in crystals.

Description: Ammonia and carbon dioxide are pressurized into the reactor where, at a pressure of 2500 psig and at a temperature of 360° F. they react to form ammonium carbamate, which in its turn converts into urea plus water.

It is necessary to maintain in the reactor an excess of ammonia in respect of the stoichiometric value, because of its favourable influence upon the conversion of carbamate into urea. In fact, the extent of urea formation is limited by equilibrium considerations so that in the reactor effluent there exist, in addition to urea and water, some carbamate and free ammonia. The last two components must be separated from the urea solution.

The reactor effluent is first expanded to 300 psig; during this operation a gaseous mixture of NH_3 and CO_2 is freed and after condensation it is recycled back to the reactor. By means of this liquid recycle it is possible to send back to the reactor a large portion of the unreacted ammonia and carbon dioxide as an aqueous solution. The remaining ammonia and carbon dioxide are vaporized from the urea solution by means of a second expansion to about atmospheric pressure. The gaseous mixture of ammonia and carbon dioxide form the tail gases which can be utilized for the production of other nitrogen compounds such as ammonium sulphate, ammonium nitrate, ammonium bicarbonate. The above described process is the "partial recycle" process.

If a total recycle of the unreacted ammonia and carbon dioxide is required the tail gases are separated. Separation is carried out in a simple two-tower system in which ammonia is absorbed by a selective solution and subsequently stripped. The towers are so designed to obtain ammonia quite completely pure and carbon dioxide. A third small tower is provided to purify a stream of process water which is discharged from the cycle.

Ammonia is liquefied, as well as carbon dioxide, and recycled back to the reactor. The urea solution free from ammonia and carbon dioxide is concentrated and prilled. The prilled urea is then dried to remove the remaining mixture and cooled to obtain a free flowing product. The prilled urea is fertilizer grade urea.

For the production of technical grade crystal urea the solution is filtered and crystallized. The crystals are centrifuged and dried. The mother liquor is concentrated and recycled back to the crystallizer.

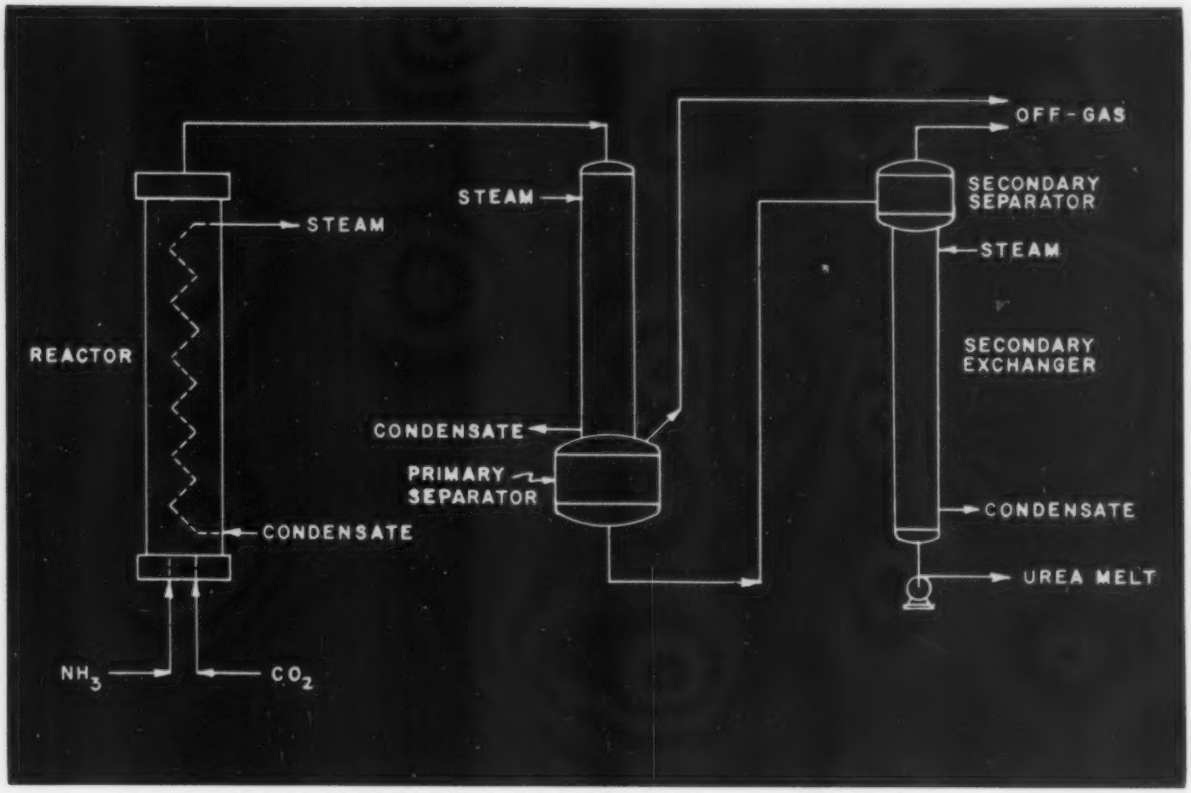
Operating Conditions: The reactor pressure is 2400 to 2600 psig and 350 to 360 F.

Yields: By the partial recycle process the overall conversion for ammonia is 65 percent and for carbon dioxide is 80 percent. The raw material requirements per ton of urea referred to 46 percent N are 0.870 ton of ammonia and 0.915 ton of carbon dioxide. The tail gases contain consequently 0.285 ton of ammonia and 0.145 ton of carbon dioxide per ton of urea. For the total recycle process the requirements per ton of urea are 0.585 ton of ammonia and 0.770 ton of carbon dioxide.

Commercial Installations: 25 commercial plants are presently in operation or under construction all over the world for a total capacity of half a million tons of urea per year.

U. S. Plants in Operation: Shell Chemical Corp., Ventura, Calif., and Spencer Chemical Corp., Vicksburg, Miss.

Under Construction: Spencer Chemical Corp., Henderson, Ky.



Urea (Inventa)—VULCAN-CINCINNATI, INC.

Application: A process for the manufacture of urea.

Charge: Anhydrous ammonia and carbon dioxide.

Description: In this process urea is synthesized by the following reactions:

$$CO_2 + 2NH_3 \rightleftarrows \underset{\text{(Carbamate)}}{NH_2COONH_4} \rightleftarrows \underset{\text{(Urea)}}{NH_2CONH_2} + H_2O$$

Liquid ammonia and liquid or gaseous carbon dioxide are reacted to form ammonium carbamate, urea and water with the evolution of a large amount of heat. The temperature of the process is controlled by removing this heat with water circulated through an exchanger in the reactor. The heat picked up in the circulated water is recovered as steam for use elsewhere in the process.

Urea, carbamate and water flow from the reactor to equipment where the carbamate is decomposed into ammonia and carbon dioxide. The off-gas is separated from the liquid urea solution and flows to the recycle section for recovery or to uses as described below. Liquid urea from this point can be used to make solution products or can be further processed by prilling to yield feed, fertilizer and industrial grade solids, by crystallization to produce industrial and pharmaceutical grade solids, or by pelletizing, granulation, etc.

This process features simplicity and low costs. The process is non-catalytic and requires no internal recirculation of any reactant or carrier. Even though the process fluid is extremely corrosive under the operating conditions, the use of a special alloy and close control of operating conditions has essentially eliminated corrosion. Reactor life in excess of ten years has been proven.

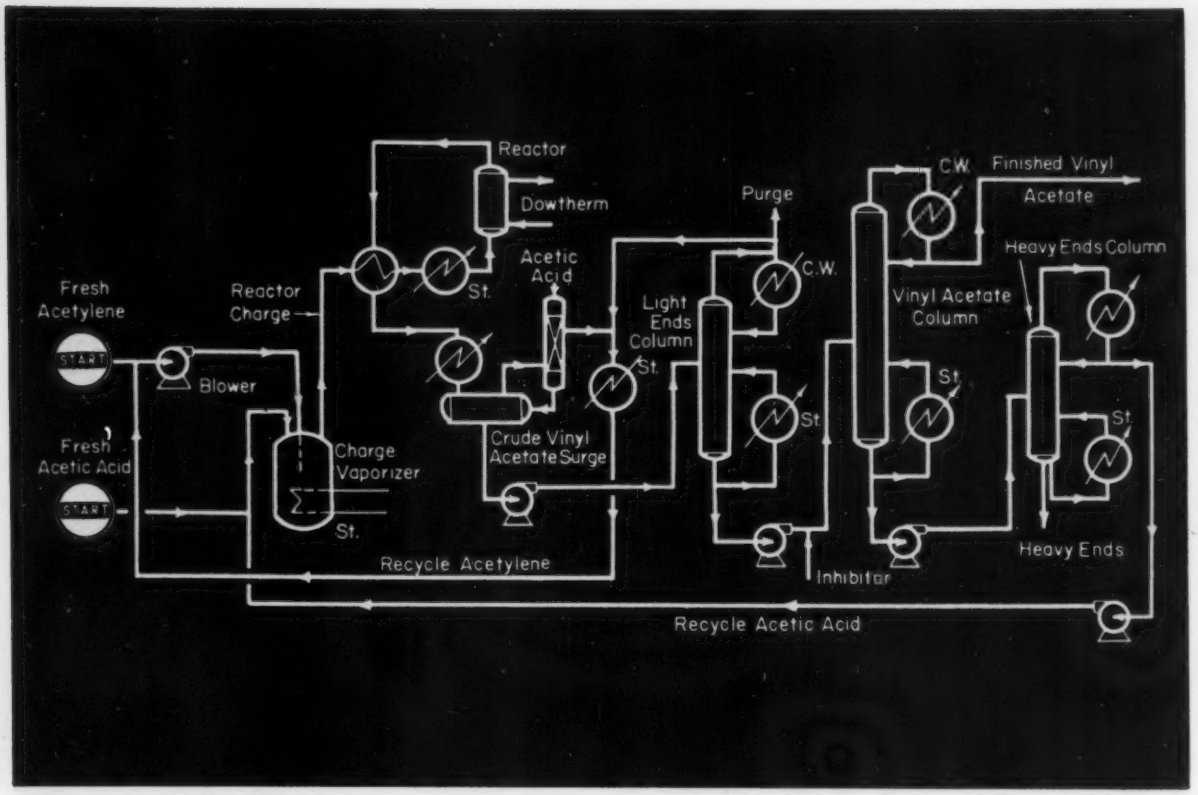
The process is versatile and can be operated on a once-through basis with the off-gas at sufficient pressure for use in production of ammonia solutions or nitric acid for neutralization of nitric or sulfuric acids. However, if none of these uses can be made of the off-gas, a recycle unit can be added. If necessary, the recycle unit can recover all of the off-gas and return it to the synthesis operation. Alternatively, the recycle unit can provide for part of the ammonia to be recovered and returned to synthesis, with the balance of the ammonia being utilized for solutions or neutralization of acids.

The process is extremely easy to start up and operate. Two United States plants were on stream and operating at design capacity in a matter of hours.

Operating Conditions: The reactor pressure is 170-200 atmospheres and 160-190 C.

Yields: A 100 ton per day plant requires 56.7 tons of ammonia and 73.4 tons of carbon dioxide.

Commercial Installations: Holzverzuckerungs, A. G., Ems, Switzerland; Sohio Petroleum Company; Southern Nitrogen Company, Inc.; Taiwan Fertilizer Co., Ltd., Republic of Korea; Hercules Powder Co., Inc.; Pakistan Development Corp. Two U. S. plants are once-through and the other employs a partial recycle. The four overseas plants are equipped with total recycle units.



Vinyl Acetate

Application: A process for manufacture of monomeric vinyl acetate.
Charge: Glacial acetic acid (99.5 percent purity); acetylene, 99.5 percent purity.
Product: Vinyl acetate monomer, 99.5+ percent purity.
Description: Vinyl acetate is produced commercially by the chemical combination of acetic acid and acetylene. The reaction is catalytic and may be carried out in either the liquid or the vapor phase. The vapor phase process will be discussed here, since it has in general replaced the older and less efficient liquid-phase operation.

Acetylene generated from calcium carbide is used in most commercial vinyl acetate plants in the United States and Canada. Certain materials present in acetylene from this source act as vinyl acetate catalyst poisons and must be removed. It will be assumed here that the acetylene has been washed (e.g., by chromic-sulfuric acids) and dried, and that it contains no phosphine or sulfur compounds.

Glacial acetic acid from outside the battery limits is blended with recycle acid in the charge vaporizer, which is a stainless steel tank equipped with acetylene sparger, steam coils, and entrainment separator. Recycle plus fresh make-up acetylene enters the tank through the sparger and passes up through the acid. The temperature of the mixture is controlled on the basis of the desired ratio of acetylene to acetic acid in the vapor passing overhead. Typical operating conditions for the charge vaporizer are 4-5 psig and 160-180 F.

The vaporized charge is preheated first by exchange with the reactor effluent and finally with steam (or heat transfer medium) before it passes to the base of the reactor. The conversion to vinyl acetate takes place in a vertical tubular unit of stainless steel construction. Typically, the tubes are 2-inch diameter by about 12 feet long, and are packed with a granular activated carbon impregnated with 20-30 wt-percent zinc acetate catalyst. The reaction is of the "hot spot" type, with the catalyst gradually deteriorating and requiring replacement every few months. For a fresh catalyst charge, the reactants are preheated to about 350 F, but as the catalyst ages this temperature is gradually increased until at the end of a cycle the reactants are preheated to about 400 F. The reaction is relatively clean at all times, with yields on the order of 95 percent of theory or better. By-products are principally acetaldehyde and ethylidene diacetate.

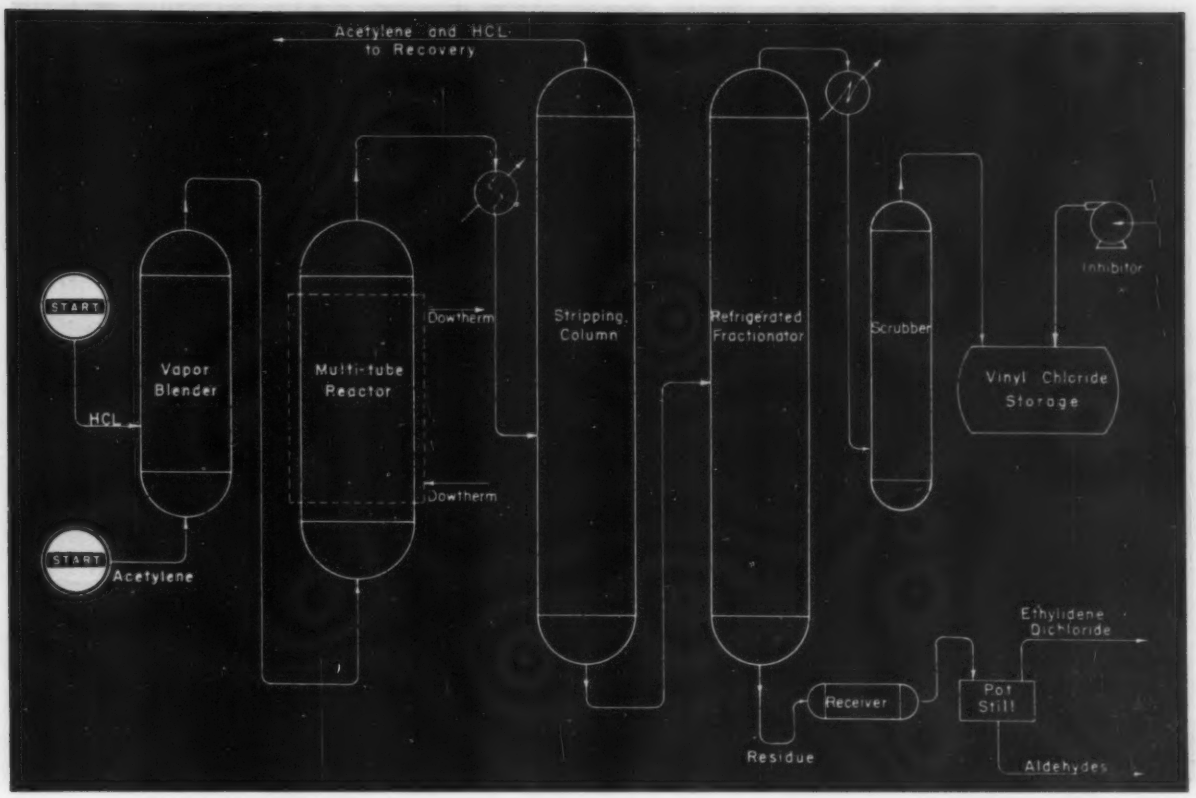
In addition to the temperature conditions noted, typical reaction conditions include: acetaylene to acetic acid molar ratio in charge, 4-5 to 1; temperature rise of gases passing through the bed, 10-20 F; operating pressure, 2-3 psig; vapor space velocity, 300-400 hr^{-1}. Acetic acid conversion is controlled to provide an optimum recycle from the distillation section, but in general is high—80 percent or more. The exothermic heat of reaction is removed by heat transfer medium in the shell side of the reactor.

The effluent gases from the reactor are cooled in two stages, first by exchange with feed vapors and finally by exchange with water or other coolant. A mixture of crude vinyl acetate and unreacted acetic acid is condensed in this step. Non-condensibles, primarily acetylene, pass overhead and recycle to the reactor.

Pure vinyl acetate monomer is obtained from the crude in a series of atmospheric distillation steps. In the first column light ends such as residual acetylene, acetaldehyde, and acetone are removed; the acetylene may be separated and recycled to the reactor. The bottoms from this column pass to the vinyl acetate finishing column, wherein a sharp separation is made between vinyl acetate and acetic acid. A polymerization inhibitor may be used in this step to prevent column fouling.

The acetic acid from the vinyl acetate column passes to a cleanup still for removal of heavy reaction products and inhibitor. Depending upon product distribution from the reactor, an additional column may be required to separate a fraction intermediate between vinyl acetate and acetic acid. The acid is recycled to the charge vaporizer.

The finished vinyl acetate has a purity of 99.5 percent or higher. It is stabilized either with 0.03 percent diphenylamine (permanent stabilizer which must be removed before the monomer can be polymerized) or 20 ppm hydroquinone (temporary stabilizer). Storage and shipment are carried out in steel equipment.
Yields: Over-all process yields are 92-98 percent on acetylene, 95-99 percent on acetic acid.
Commercial Installations: This process or a variation is used at the following plants: Air Reduction Co., Calvert City, Ky.; Union Carbide Chemicals Co., Niagara Falls, N. Y. and Texas City, Tex.; Shawinigan Resins Corp., Springfield, Mass.; Shawinigan Chemicals, Ltd., Shawinigan Falls, Quebec.



Vinyl Chloride from Acetylene—NAUGATUCK CHEMICAL

Application: A process for the manufacture of vinyl chloride.

Charge: Acetylene and hydrogen chloride are the charge.

Product: The product is vinyl chloride monomer.

Description: Hydrogen chloride gas with a water content of less than 0.02 weight percent is mixed with dry acetylene in a vapor blender to react in equal molar quantities. The hydrogen chloride must be dry to avoid excessive corrosion and to hold down the quantity of acetaldehyde formed as a by-product. From the vapor blender, the gas mixture is fed to multi-tube reactors. The reactors are connected in banks of nine for parallel flow of gases. Each tube is packed with activated carbon pellets impregnated with catalyst containing mercuric chloride.

The reaction must be initiated by heat supplied to the reaction mass using a circulating heating medium on the shell side of the reactor. Once the reaction is started, it is highly exothermic and the circulating medium used to supply heat is now used as a coolant.

The main reaction proceeds as follows:

$$HC \equiv CH + HCl \rightarrow CH_2 = CHCl \text{ (Vinyl Chloride)}$$

One of the side reactions for the formation of Acetaldehyde by hydration of acetylene is as follows:

$$HC \equiv CH + H_2O \rightarrow CH_3CHO \text{ (Acetaldehyide)}$$

The other side reaction for the formation of ethylidene chloride proceeds as follows: $CH_2 = CHCl + HCl \rightarrow CH_3$-$CHCl_2$ (ethylidene chloride).

The temperature in the reactor is controlled to about 200 F. The exact temperature is dependent upon the catalyst age and physical condition.

Gases from the reactor contain the product, vinyl chloride, as well as by-products such as ethylidene chloride and aldehydes. Small amounts of unreacted hydrogen chloride and acetylene are also present. These gases are cooled before being fed to a combination stripping and fractionating operation. In this operation the unreacted acetylene and hydrogen chloride are removed from the crude vinyl chloride.

In a refrigerated fractionating column, the vinyl chloride is taken overhead. The ethylidene chloride and the aldehydes are removed from the bottom of this tower. These by-products then go to a pot still where the ethylidene chloride is separated from the aldehydes.

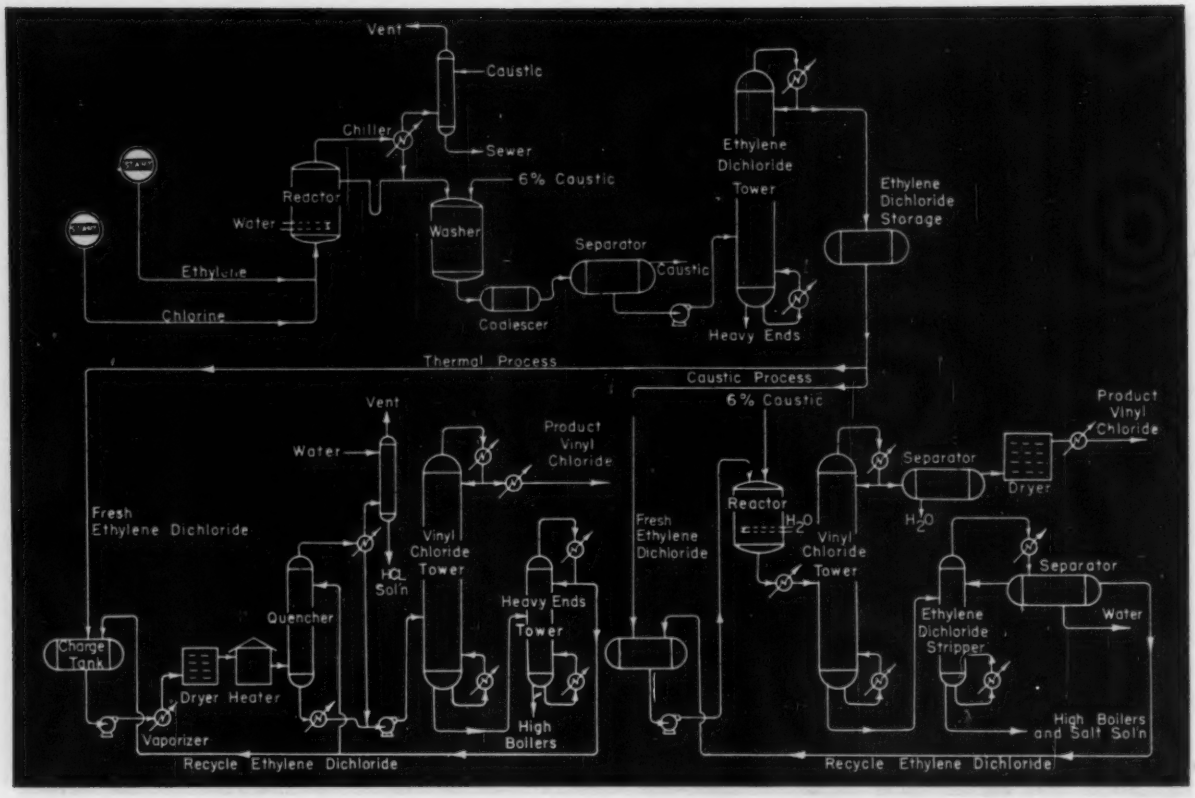
The vinyl chloride going overhead is sent to a scrubber where trace impurities are removed by caustic and water. From the scrubber, the vinyl chloride is sent to storage after the addition of a small amount of phenol which acts as a polymerization inhibitor. Storage tanks for vinyl chloride monomer are stainless steel.

Operating Conditions: The major operating conditions are given in the text of the description.

Yields: Typical yield data are given below:

Yield of vinyl chloride, based on acetylene—85-90 percent.

Acetylene consumption—42-46 pounds/100 pounds vinyl chloride.



Vinyl Chloride from Ethylene

Application: A process for manufacturing vinyl chloride.

Charge: Ethylene, 90-95 percent purity; chlorine, 99+ percent purity.

Product: Vinyl chloride monomer, 99.5+ percent purity.

Description: The production of vinyl chloride from ethylene and chlorine is based on the intermediate production of ethylene dichloride (1,2 dichloroethane). There are two commercially-important processes for the dehydrochlorination of the ethylene dichloride to form vinyl chloride. Both will be described below. For a description of Ethylene Dichloride manufacture see Page 239.

Thermal Process—Fresh and recycle ethylene dichloride in approximately equal proportions form the charge for this process. The charge is pumped to about 50 psig, vaporized in a steam-heated exchanger, and passed through a bed of desiccant for removal of water traces which could cause corrosion later in the process. The dry vapor enters the direct-fired cracking furnace, which contains stainless steel tubes. The exit gases reach a temperature of 900-950 F with about 50 percent of the ethylene dichloride being cracked according to the reaction:

$$C_2H_4Cl_2 \rightarrow C_2H_3Cl + HCl$$

Yields of vinyl chloride as high as 95-98 percent are obtained. A certain amount of carbon deposition occurs, and the cracking unit must be shut down periodically for coke removal. To avoid this, some operators pack the reaction tubes with non-porous material, e.g., smooth gravel, to minimize skin cracking.

The effluent gases are quenched rapidly by direct-contact with a stream of recycle ethylene dichloride. Quenched gases pass through a surface condenser, and the noncondensibles are finally scrubbed with water to recover the hydrogen chloride.

The combined liquid streams from quencher and condenser are fractionated and vinyl chloride of 99.5+ percent purity obtained. The vinyl chloride tower pressure is such that the entire overhead stream is totally condensed by chilled water. The product vinyl chloride monomer is stored in pressure tanks at low temperature.

Caustic Process—Fresh and recycle ethylene dichloride is mixed with 6 percent caustic in a mole ratio 2:1 ethylene dichloride:sodium hydroxide and charge to a steel reactor. The reactants are pumped and heated to the reaction conditions of 150 psig and 290 F. After a residence time of 2-3 minutes, 90 percent of the ethylene dichloride is converted, according to the reaction:

$$C_2H_4Cl_2 + NaOH \rightarrow C_2H_3Cl + NaCl + H_2O$$

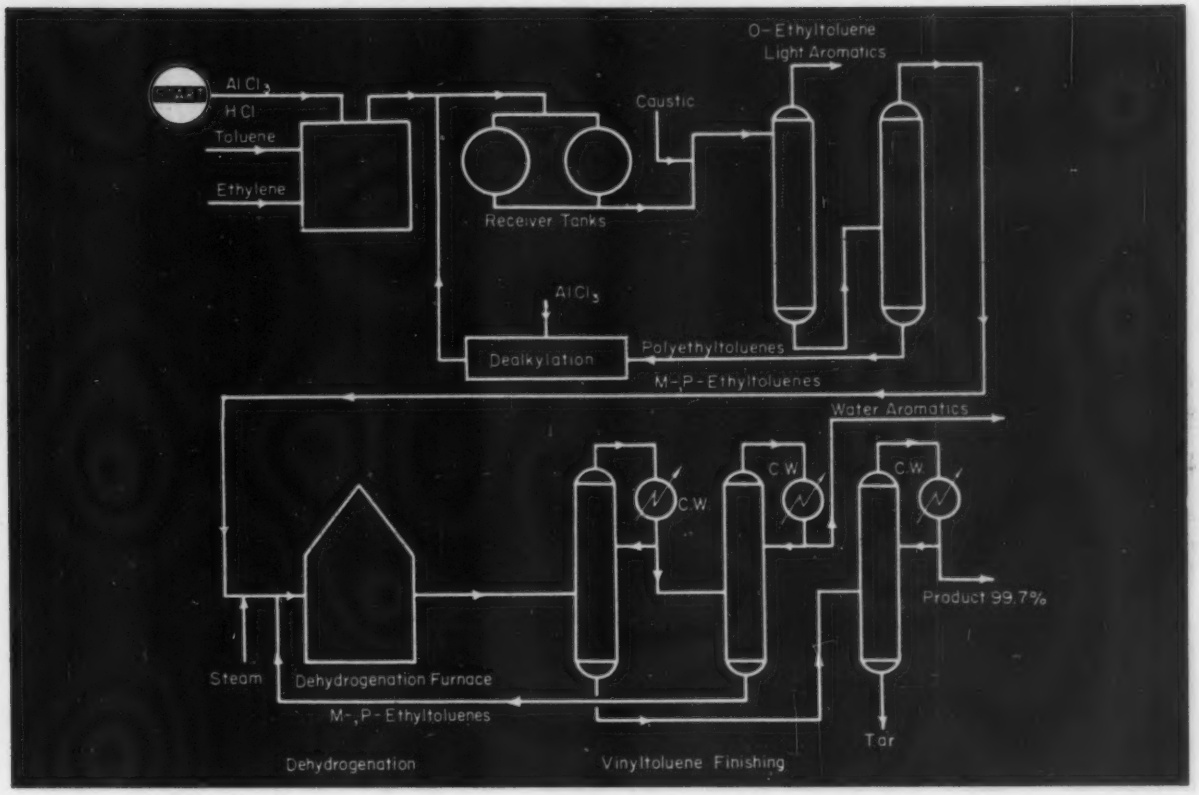
The yield of vinyl chloride is almost quantitative; minor side-products are ethylene glycol, acetylene, and acetaldehyde.

The reactor overflow is cooled and pressured to the vinyl chloride column which operates at a pressure such that the entire overhead can be condensed with chilled water. The product vinyl chloride monomer is stored in pressure tanks at low temperature.

The bottoms from the vinyl chloride tower passes to another still where a water-ethylene dichloride azeotrope is carried overhead. Water is decanted and the dichloride is recycled to process. The bottoms stream from this final still contains high boilers, salt, and water, and is discarded.

Yields: Over-all process yield, vinyl chloride from chlorine or ethylene: 90 percent.

Commercial Installations: This process or a variation is used by: Union Carbide Chemicals Company, Texas City, Texas; Monsanto Chemical Company, Texas City, Texas; Dow Chemical Company, Freeport, Texas, Midland, Mich.; Diamond Alkali Company, Deer Park, Texas.



Vinyl Toluene

Application: A process for the manufacture of mixed m-, p-vinyltoluene.

Charge: Toluene, ethylene, aluminum chloride, and hydrochloric acid or ethyl chloride.

Products: High purity mixed m-, p-vinyltoluenes, o-ethyltoluene, small amounts of other coproducts.

Description: Toluene is alkylated by high purity ethylene using anhydrous $AlCl_3$ and HCl as catalyst. The ethylene is bubbled through the toluene-catalyst mixture and the crude reaction mixture overflows to receiving tanks and is neutralized by caustic contact. The neutralized crude alkylate is continuously fractionated to recover the various aromatics: benzene, toluene, ethylbenzene, xylenes; o-, m-, and p-ethyltoluenes; and polyethyltoluenes. The polyethyltoluenes are dealkylated by reaction with toluene and an $AlCl_3$ catalyst, and the resulting ethyltoluenes are then fed to the distillation system. The o-ethyltoluene is separated from the m- and p-ethyltoluenes by precise fractionation, since its presence is detrimental to the dehydrogenation following.

The mixed m- and p-ethyltoluenes are diluted 3:1 with steam and the hydrocarbon-steam mixture then passed over a dehydrogenation catalyst at 580 to 625 C. The steam reduces by-product make and continuously regenerates the catalyst by the water-gas reaction.

The crude dehydrogenated mixture is finished by continuous fractionation in three steps as shown below:

VINYL TOLUENE FINISHING

Step	Distillate	Residue
1	Benzene, toluene, xylenes, ethylbenzene, styrene, m- and p-ethyltoluenes	m- and p-vinyltoluenes and tar
2	Benzene, toluene, xylenes, ethylbenzene, and styrene	m- and p-ethyltoluenes
3	m- and p-vinyltoluenes	Tar

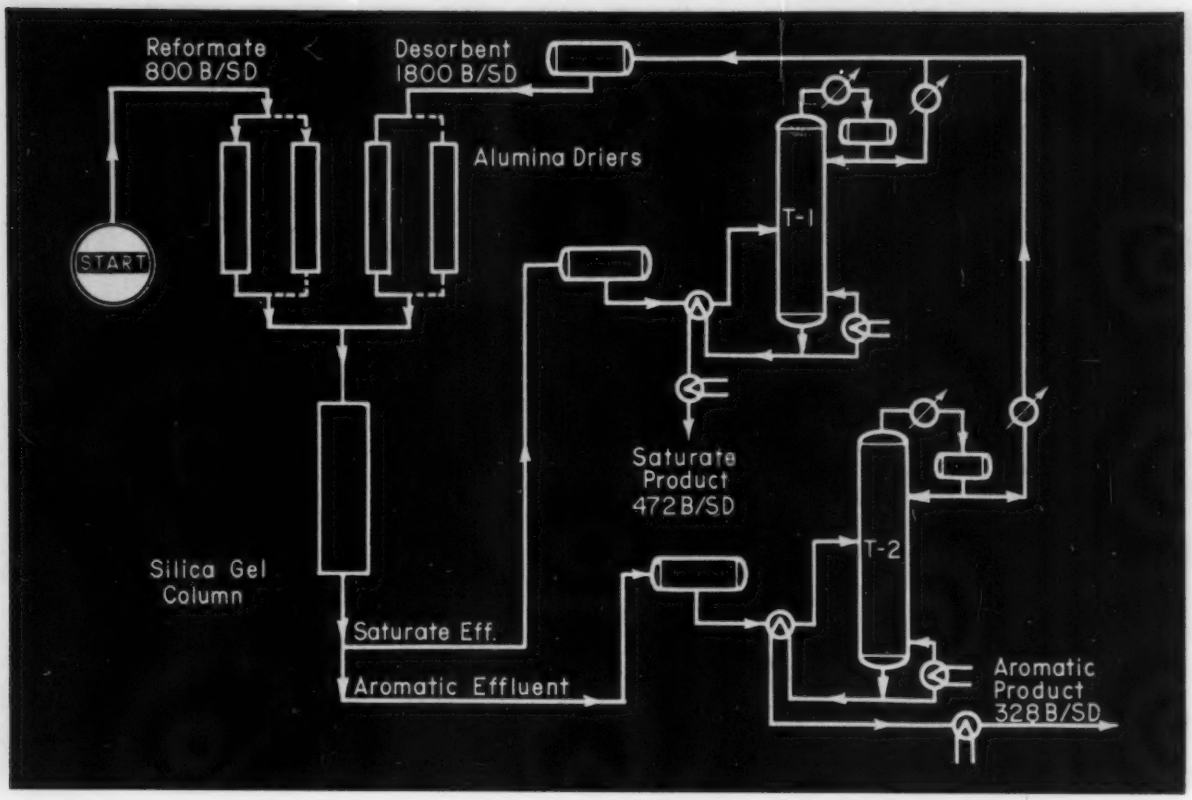
The fractionations are conducted at reduced pressures ranging from 15mm to 140mm. mercury absolute. The purified mixed vinyltoluenes are inhibited and stored in the same way as styrene.

Operating Conditions: Critical items in the process are: (1) the need for precise fractionation of the ethyltoluene alkylate for removal of the ortho isomer, since the total boiling point spread is only 3.1 C.; and (2) the use of steam as a diluent in the dehydrogenation to reduce the byproduct formation.

Yields: Actual yields are not available, but are commercially satisfactory.

Commercial Installation: This process is used commercially by Dow Chemical Co., Midland, Mich.

Reference: Boundy, R. H., and R. F. Boyer (Eds). Styrene: Its Polymers, Copolymers, and Derivatives. A.C.S. Monograph No. 115. New York, Reinhold Publishing Co., 1952, Chapter 17.



Arosorb— SUN OIL COMPANY

Application: The process is designed to separate aromatics from saturates in various refinery streams.

Charge: The Arosorb unit shown is in actual operation and processes a 250-400 F. cut of catalytic reformate. It has also been used to dearomatize kerosine, and can separate aromatics boiling up to 700 F from saturates.

Products: These can include thermally stable jet fuel, high smoke point kerosine, high-purity, high-boiling aromatics, high-octane aromatics from motor reformate, and nitration-grade benzene, toluene, and xylenes.

Description: The stream quantities and the method of operation apply specifically to the processing of 800 BPSD of catalytic reformate. The desorbent consists of benzene diluted with about 40 percent of 160-190 F saturate fraction. The charge and desorbent are passed over activated alumina driers which will remove water and other gel poisons. After pretreatment the charge flows through the gel column where the charge aromatics are adsorbed displacing the desorbent aromatics left from the previous cycle. The desorbent then follows, desorbing the charge aromatics with desorbent aromatics to complete the cycle.

The effluent from each cycle is divided into two parts. The first portion containing the saturates goes to fractionator T-1 where the saturate product is removed as bottoms and the desorbent distilled overhead. The second portion, containing the charge aromatics, flows to T-2 where the aromatic product is withdrawn as bottoms and the desorbent is taken overhead. The desorbent streams are combined for re-use.

Modification in this process include use of a desorbent boiling higher than the charge, dilution of viscous charge stocks, and the recycling of a portion of the effluent for high purity operation.

Operating Conditions: The gel columns are usually operated at atmospheric temperatures. However, if a reduction in viscosity is desirable, the column may be operated at temperatures up to 150 F.

The operating pressure is fixed by the vapor pressure of the materials processed and by the height of the gel column needed for the specific application.

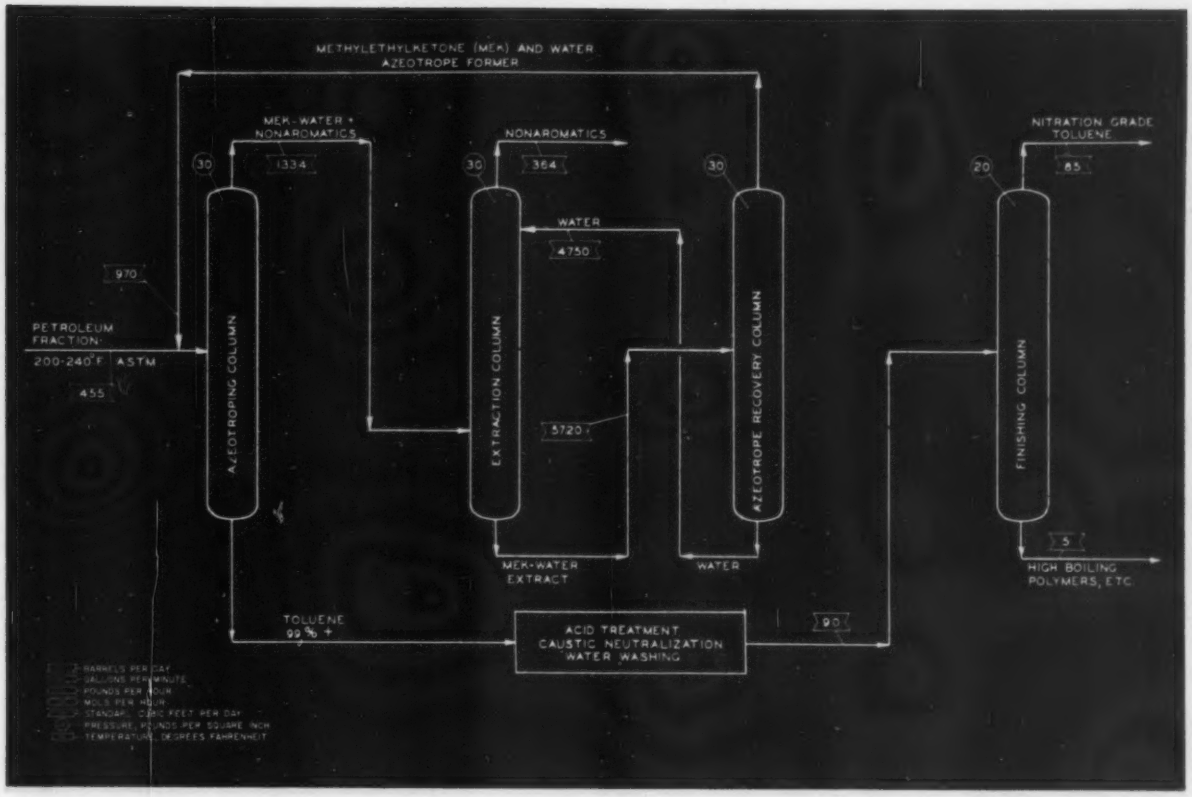
Typical inlet pressure for motor reformate processing is 150 psi.

Yields:

	Percent Purity	Percent Recovery
Benzene, Toluene, and Xylenes (from reformate)	99+	95
Motor Reformate Aromatics (100 + F-1 Clear)	90	90
Dearomatized Kerosine (35 mm + smoke point)	98	90

Commercial Installation: Petrocarbon Chemicals, Inc., Irving, Texas.

Reference: PETROLEUM REFINER, May,'52,p100.



Azeotropic Fractionation—UNION OIL COMPANY

Application: The process has been used successfully for the production of high purity toluene from catalytic reformates and virgin naphthas. This process also can be used for the production of high purity benzene and xylene from petroleum and coal tar fractions.

Charge: The charge stock for this process is the appropriate boiling range distillate containing either benzene, toluene or xylene. It may be either a virgin or cracked naphtha or the product derived from a catalytic reforming operation. The process shown in the flow diagram uses an aromatic cut from a catalytic reformer that has been previously split into benzene, toluene, and xylene concentrates. The toluene concentrate is charged to this process.

Product: Nitration-grade benzene, nitration-grade toluene or 95 percent plus xylene fraction can be produced.

Description: The principle of azeotropic fractionation is used to separate materials having similar boiling points. An azeotropic former is used to change the boiling point of a portion of the original mixture; thus, a separation can be effected between two portions of a mixture by simple fractionation.

A flow diagram illustrating this principle is shown above. In this case, a mixture of methyl ethyl ketone and water is used as the azeotrope former. Major production of nitration-grade toluene has been carried out by this process.

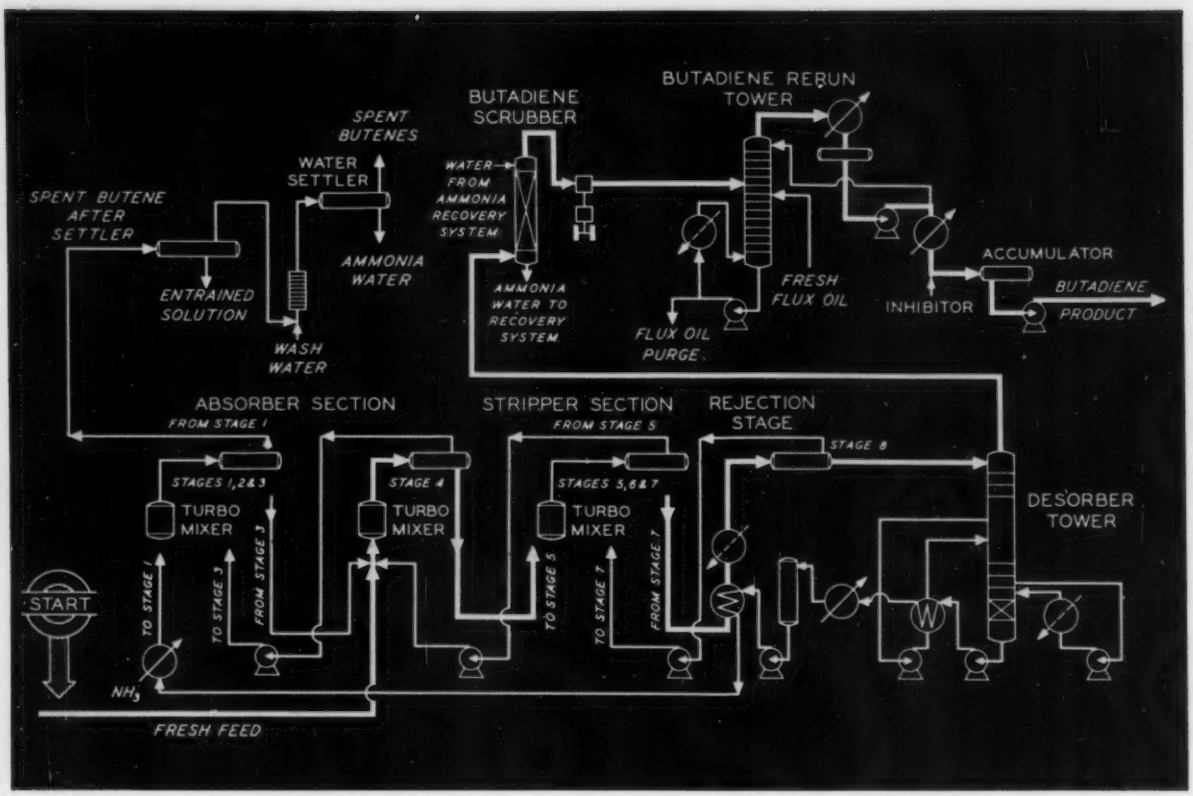
The azeotrope former is added to the azeotropic distillation column with the toluene-containing fraction. A constant boiling mixture of non-aromatic hydrocarbons, water and methyl ethyl ketone passes overhead, giving a bottom product of substantially pure toluene. To meet the specifications for nitration-grade toluene, a slight acid treat is used. The toluene is then caustic neutralized and water washed before being rerun in a finishing column.

The overhead from the azeotropic column, containing the non-aromatics water and the methyl ethyl ketone, is fed to the extraction column. The non-aromatics are removed overhead while the methyl ethyl ketone is extracted with water and goes out the bottom of the column. This stream is then fed to the azeotrope recovery column where the methyl ethyl ketone-water mixture used as the azeotrope former is recovered and recycled to the azeotroping column. Water from the bottom of the recovery column is recycled directly to the extraction column.

Operating Conditions: In the recovery of toluene by the Azeotropic Fractionation process, a 2.5 to 1.0 ratio of methyl ethyl ketone to non-aromatic fraction is charged to the azeotropic distillation column. Other major operating conditions are indicated on the flow sheet.

Yields: Commercial yields have shown an over-all recovery in the range of 95 to 98 percent.

Commercial Installations: One unit at the Oleum Refinery of the Union Oil Company operated successfully throughout the war period producing nitration-grade toluene.



Butadiene Extraction—ESSO RESEARCH AND ENGINEERING COMPANY

Application: A liquid phase selective solvent extraction process for recovering butadiene.

Charge: A butane-butene-butadiene cut produced by catalytic dehydrogenation of normal butenes or by high temperature cracking of naphtha or gas oil.

Product: Butadiene of 98.5 + percent purity.

Description: The three major components of the charge stream, butadiene, butanes and n-butenes, have close boiling points and it is necessary to use a solvent which will selectively absorb the butadiene. The solvent used is an aqueous ammoniacal cuprous acetate solution of this approximate composition:

	Mols/Liter	Weight Percent
Total Copper	3.3	17.5
Cuprous Copper	3.0	....
Acetate (Acetic Acid)	4.0	20.0
Ammonia	11.0	15.5
Water	31.3	46.9
	....	100.0

In the absorber section, the stripper section and the rejection stage, the butadiene is contacted and absorbed by the solvent while the majority of the butanes and butenes are rejected from the system. The solvent is mixed with the hydrocarbon feed in a series of stages, each of which consists of a turbo mixer and a settler. The hydrocarbon not absorbed by the solvent is recycled back to other stages for additional contacting with the solvent until essentially all the butadiene is finally absorbed. The hydrocarbons that are rejected are water washed and then are recycled to the catalytic dehydrogenation plant or are diverted to alkylation plant feed.

The solvent containing the butadiene is fed to the desorber tower where the hydrocarbon stream is separated from the solvent. The hydrocarbon stream is sent to the butadiene scrubber where water washing removes ammonia.

From the scrubber the butadiene stream goes to the butadiene rerun tower where polymers and other high boiling impurities are removed. A flux oil is used as a wash in the bottom of the re-run tower. After the addition of an inhibitor, the final product is sent to storage.

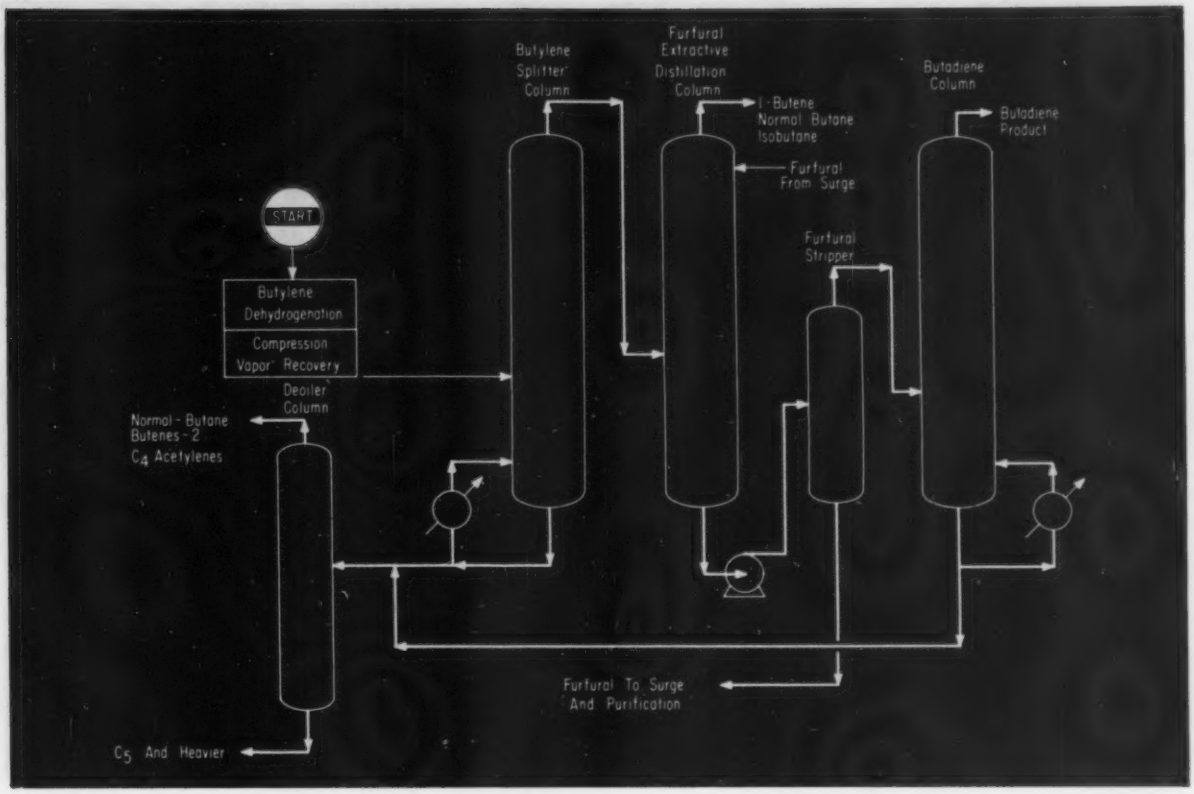
Operating Conditions: The principal operating conditions are:

Ratio of Copper solution to Feed, lb./lb.	8.0
Lean Solution Temperature, F	8
Lean Solution Pressure, psig	45
Rejection Temperature, F	100
Desorber Bottom Temperature, F	175
Desorber Bottom Pressure, psig	15

Yields: Typical yields and analyses of the feed and products are as follows:

	Feed Mol. Percent	Spent Butenes Product, Mol. Percent	Butadiene Product, Mol. Percent
C3	0.2	0.3	0.3
Butadiene	16.7	0.9	98.5 (Min.)
i-Butene	4.9	5.7	0.2
n-Butenes	62.8	75.1	1.0
Butanes	15.3	17.9	....
C5	0.1	0.1	....
	100.0	100.0	100.0

Butadiene Recovery (percent of butadiene in feed)—98 percent.



Butadiene Extraction (Furfural)—PHILLIPS PETROLEUM COMPANY

Application: A process to recover butadiene or high-purity butylenes from a stream of mixed hydrocarbons.
Charge: A depropanized C_4 fraction from a dehydrogenation or cracking operation.
Product: Polymerization grade butadiene of a minimum purity of 98 weight percent or total butylenes in the range of 75 to 98 weight percent.
Description: The material from which butadiene is to be recovered is subjected to prefractionation to remove propane and lighter components from the feed before extraction. The propane recovered is returned to the battery limits and sold as LPG or it may be consumed as fuel. Certain plants recycle the recovered n-butane and butenes-2 to a dehydrogenation section where they are converted to butadiene. In this event, the butylene splitter bottoms and the butadiene column bottoms are combined and deoiled before being recycled.

The depropanized feed stream containing all seven C_4 isomers enters the butylene splitter column where butadiene is concentrated in the overhead product. The bottoms product contains most of the high-boiling butene-2, as well as part of the low-boiling butene-2 and C_4 acetylenes. A small portion of the normal butane goes overhead, while most goes out with the bottoms product.

The overhead product of the butylene splitter is charged to the extractive distillation column. Lean furfural is charged as a solvent near the top of the column. This column acts as an absorber, preferentially absorbing butadiene and small amounts of the other C_4 unsaturates.

The rich furfural leaving the bottom of the extractive distillation column is pumped to a stripping column where the hydrocarbons (butadiene, butenes-2, and traces of other C_4 hydrocarbons) are stripped from the furfural and sent to the final separation step (the butadiene column). In the butadiene column, butenes-2 and C_4 acetylenes are removed as a bottoms product and butadiene of a minimum purity of 98 weight percent is produced as a side draw near the top of the column or as an overhead product.

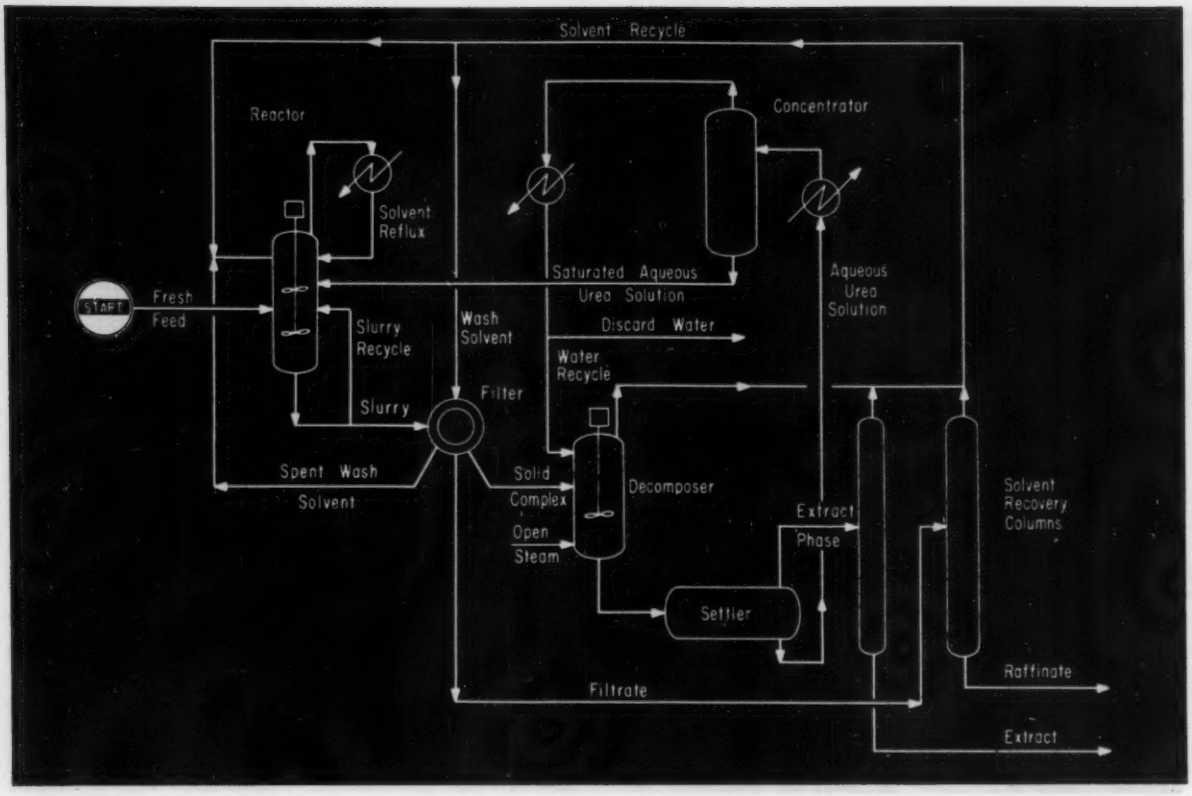
Although the present principal use for butadiene is synthetic rubber, it is rapidly becoming known as a chemical intermediate. Butadiene is now considered as a raw material for nylon manufacture and thermosetting resins. Other new uses are being developed.

The furfural extractive distillation column can also be used to recover butylenes from a mixed hydrocarbon stream for alkylation feedstock or other purposes. Any desired purity can be yielded as furfural stripper overhead product by adjusting the operating conditions of the extractive distillation column.

Commercial Installations: About 66 percent of all the butadiene produced in the U. S. is recovered by furfural extractive distillation.

Typical Analyses of Furfural Extractive Distillation System Mol Percent

COMPONENT	BUTADIENE EXTRACTION				BUTYLENE EXTRACTION		
	Extractive Feed	Column Overhead	Stripper Overhead	Butadiene Column Product	Extractive Feed	Column Overhead	Furfural Stripper Overhead
Isobutane	5.8	8.3	....	....	....	....	....
Isobutylene	6.8	9.8	0.2	.2	....	....	....
Butene-1	29.8	42.8	0.4	.5	1.1	1.4	1.3
Butadiene	26.2	0.4	83.2	98.5	0.3	....	0.4
n-Butane	18.1	21.6	....	....	70.3	94.5	2.1
Butene-2 L.B.	13.0	15.4	9.2	0.6	18.0	2.6	96.2
Butene-2 H.B.	3.3	1.7	7.0	0.2	10.3	1.5	



Extractive Crystallization with Urea

Application: A process for the separation of straight-chain components from a mixture of hydrocarbons. Examples: Isomer fractionation, dewaxing of lubricating oils and jet fuels, and preparation of pure n-paraffin fractions.

Charge: A liquid hydrocarbon fraction, saturated aqueous urea solution, and a selected hydrocarbon-soluble solvent.

Products: These include (1) the straight-chain extract and (2) the raffinate—that portion of the feed which did not form a crystalline complex with urea.

Description: Urea forms crystailine complexes with straight-chain compounds but not with most branched-chain and ring-type compounds. The crystals are stable and easy to handle, and they can be decomposed readily for recovery of the extracted fraction and urea. The urea is returned to the process. There are many possible variations of extractive crystallization with urea, but they all embody the same principles. Selection of the non-aqueous solvent is influenced by the nature of the feed and the specific application of the process. In the dewaxing application described here, methylene chloride (B. Pt. 106 F) is a suitable solvent.

Approximately equal volumes of fresh feed, solvent, and aqueous urea solution saturated at 160 F are added to the agitated reactor which operates at 95 to 115 F. Temperature is controlled by solvent reflux. Some slurry is recycled to promote good crystal growth. Slurry from the reactor is sent to a separator or filter for removal of the solid complex from the liquid phase. The filtrate is sent to a fractionator for recovery of solvent from the raffinate, or dewaxed feed.

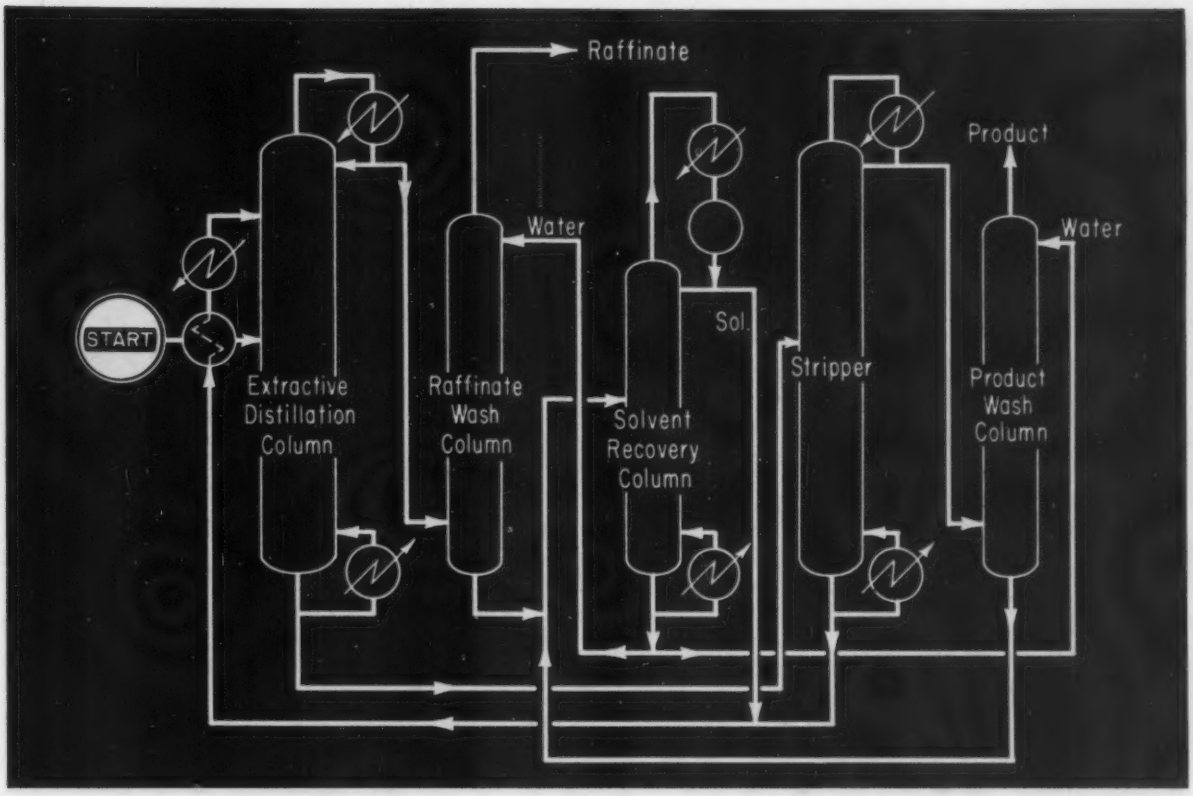
The solid complex may be given a light wash to remove occluded liquor. The spent wash solvent is sent to the reactor, and the solid complex is charged to a vessel for decomposition of the complex. This is accomplished by the addition of water and open steam to dissolve and heat the complex to yield an urea-free extract phase and an equeous urea solution at a temperature around 170 F. The solid complex is unstable in an aqueous medium unless it is nearly saturated. Solubility of urea in water increases rapidly with a small increase in temperature, so the decomposition is easy to accomplish without excessive dilution. The aqueous urea and extract mixture is sent to a settler from which the upper extract phase is sent to a fractionator for solvent recovery. The aqueous urea solution is heated and sent to a concentrator for removal of water to give a solution equivalent to saturation at 160 F. Most of the water removed is returned to the decomposer.

Operating Conditions: The process can be operated at close to atmospheric pressure without refrigeration for most applications. Maximum process temperatures do not exceed approximately 180 F. The urea solution is kept saturated in the reaction step to obtain good extraction efficiency.

Yields: Pour points of lubricating oils have been lowered as much as 40 to 90 F in some applications. Normal paraffins of 95 to 99 percent purity can be obtained from non-olefinic feeds.

Commercial Installations: L. Sonneborn Sons, Daugherty Refinery, Pennsylvania; Deutsche Erdol A. G., Heide, Germany (essentially the process described here); Standard Oil Company (Indiana), Whiting, Indiana. There are several other plants of semi-commercial scale.

References: PETROLEUM REFINER, Vol.36,No.5,p217,May (1957); PETROLEUM REFINER, Vol.34,No.4,p127,April (1955).



Extractive Distillation (Acetonitrile)— SHELL DEVELOPMENT COMPANY

Application: A process for the separation of saturate-olefin or olefin-diolefin of C_4's or C_5's.

Product: The products recovered may thus be butane-isobutane, pentane-isopentane, C_4 olefins, C_5 olefins, butadiene, or crude isoprene which may contain cyclopentene and/or cyclopentadiene.

Description: The schematic flow diagram is illustrative for all the separation mentioned. Raw feed, usually vaporized by heat exchange with solvent, is introduced approximately midway in the extractive distillation column. The solvent, acetonitrile with water in concentrations up to 10 percent by weight, is introduced near the top of the column at approximately solvent tray temperature. Above this solvent port, a few trays are generally provided for solvent knockback out of the overhead.

The fat solvent leaving as bottom product becomes feed for the solvent stripper column from which hydrocarbon product is recovered overhead; lean solvent, recovered as bottom product, is returned through exchangers to the extractive distillation columns.

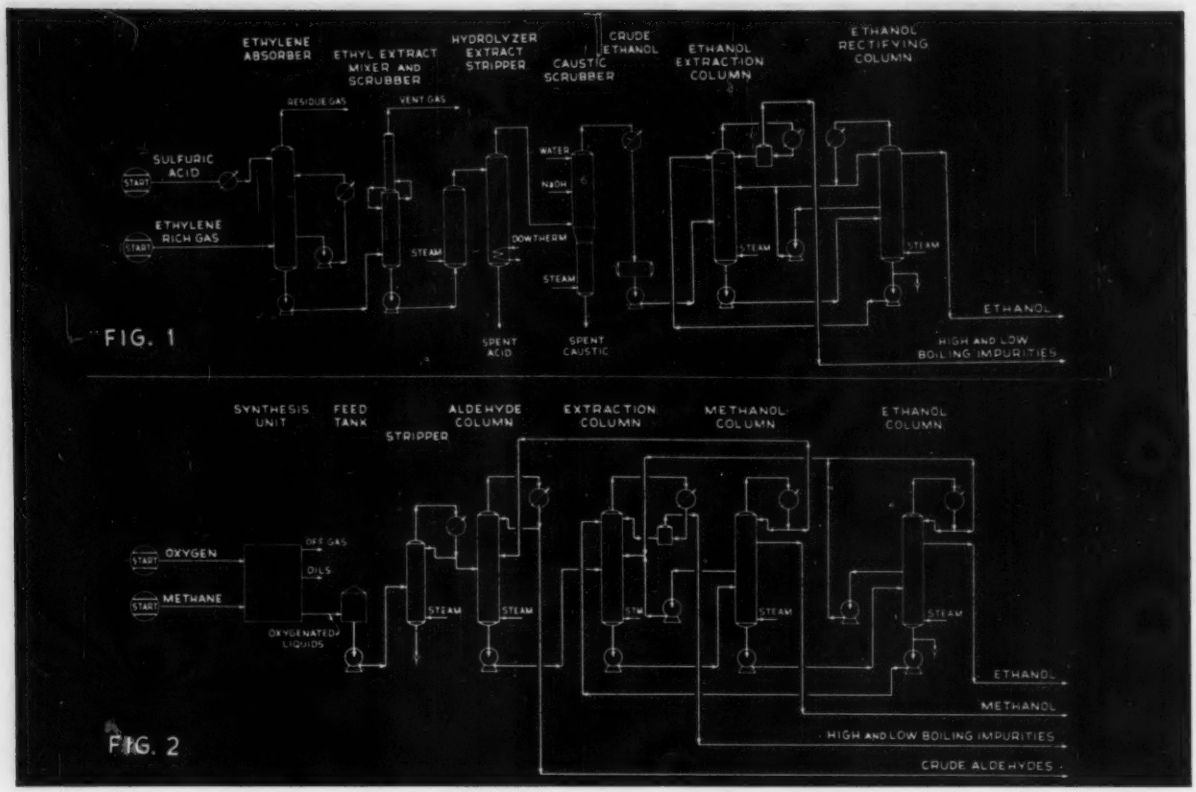
Both the hydrocarbon raffinate and product streams are water washed in separate columns to reduce acetonitrile concentrations to trace quantities.

A small bleed stream from the circulating solvent is also washed in the raffinate wash column to remove the small concentrations of heavy hydrocarbons which may have entered with the raw feed and also to remove small concentrations of decomposition products.

The fat water streams from these two columns become feed for the solvent recovery column. The recovered solvent is returned to the system and the lean water is recycled to the wash column.

Acetonitrile, anhydrous or aqueous, when used as an extractive distillation solvent, produces alpha-values (volatility ratios) which are substantially superior for saturate-olefin separations and somewhat greater for olefin-diolefin separations than those obtained with other solvents (e.g., acetone or furfural). It is non-corrosive and is essentially stable, having only a small decomposition rate. Its physical properties of low molecular weight and relatively low density and boiling point give it certain process advantages of economic significance.

Specification purities of products are generally obtainable at high recoveries. The process has been successfully applied commercially for removing butane and isobutane from butylenes which are recovered from butadiene manufacture.



Extractive Distillation of Alcohols— STONE & WEBSTER ENGINEERING CORP.

Application: A process for recovery and purification of high purity alcohol.

Charge: Hydrocarbon oxidation products may be processed to recover essentially all of their alcohol content.

Product: High-grade industrial alcohols or neutral spirits meeting rigid chemical and organoleptic spifications.

Description: Water is used as the extractive medium, with two or more columns required, depending on the source and impurities in the raw alcohol.

In Figure 1 an extractive distillation method is shown for ethanol produced from ethylene by sulfation and subsequent hydrolysis. Ethanol so produced is relatively pure and may be furnished in a two column system. Fermentation alcohol can be processed in a two column system similar to that shown in Figure 1, after stripping from the beer and removal of aldehydes in conventional equipment.

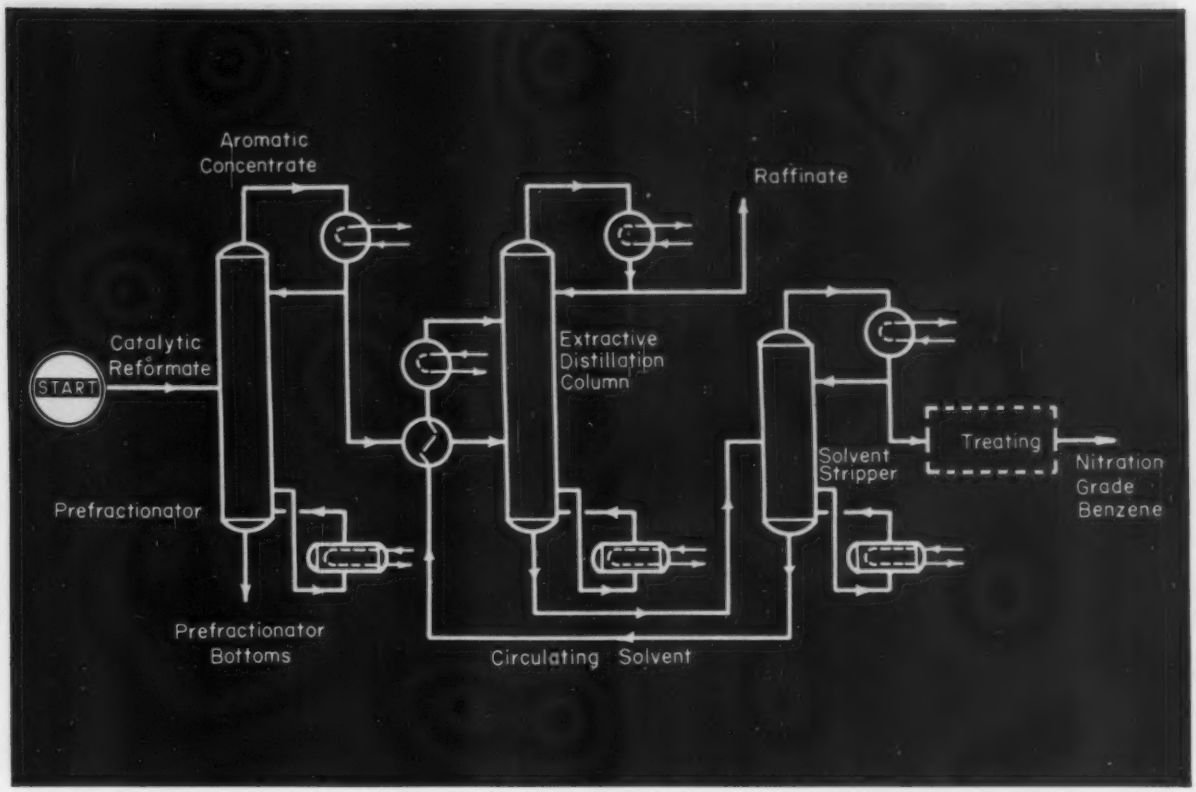
Crude ethanol is fed into the mid-portion of the extraction column. Sufficient water is added to the top plate of the column to give a low proof bottoms and live steam is added to the base. As the vapor ascends the stripping section of the column, all of the volatile compounds tend to be stripped out of the descending low ethanol concentration liquid; however, at this low ethanol concentration, both the low and high boiling impurities have higher volatility and are preferentially removed upwards. The vapors above the feed plate are washed with large quantities of water, such that the more soluble ethanol is absorbed and returned to the stripping section, eventually flowing out the bottom. The overhead vapors, consisting essentially of impurities and water, are condensed and returned to the top plate as reflux. The impurities, substantially free of ethanol, are drawn off from this reflux stream as the overhead product from the column.

The dilute bottoms from the extraction column are fed to the rectifying column where the ethanol is withdrawn as a pasteurized product near the top. A heads cut from the top and a high boiler recycle stream near the feed plate are returned to the dilute zone of the extraction column above the feed point. Water, free of ethanol, flows from the base of the column and is recycled back as dilution water to the extraction column. Substantially all of the ethanol contained in the feed is recovered as high-grade neutral spirits of superior quality to those produced by a unit employing conventional heads and concentration columns.

Figure 2 illustrates a unit that will recover ethanol from a mixture of oxygenated compounds, which are present in processes of partial oxidation of light aliphatic hydrocarbons, either for the purpose of producing synthetic fuels or organic chemicals as such. A crude distillate of this nature must be processed by extractive distillation if complicated and expensive chemical treatment is to be avoided.

The water layer effluent from the reaction is first passed through a stripper to concentrate partially the chemicals and to remove acidic impurities. The acid-free feed is then fed to an aldehyde column for the removal of acetaldehyde and other low boiling impurities before entering the extraction column. If there is a considerable quantity of methanol present in relation to the ethanol, the two alcohols may be purified together and separated from each other after the extraction step in two separate columns, as indicated in Figure 2. However, if the amount of methanol is small in relation to the ethanol content, the aldehyde column may be operated to take methanol and lighter compounds overhead, and the methanol column can be eliminated. The operation of the extraction column is the same as in the system shown in Figure 1 and high-quality methanol and ethanol are produced.

Commercial Installations: Numerous installations are in operation refining not only distillates from ethylene hydration and oil synthesis plants but also from fermentation processes.



Extractive Distillation (Aromatics Recovery)—SHELL DEVELOPMENT CO.

Application: The process has been used successfully for recovering nitration grade benzene, toluene, or xylene from appropriate petroleum fractions.

Product: The product has a purity of 98 to 99 percent and is satisfactory for most uses; however, acid treating and redistillation may be necessary to meet nitration specifications.

Description: The separation of aromatics from non-aromatic is accomplished by distillation of the petroleum fraction in the presence of an extractive solvent which has selective solvency for the aromatic and thus reduces its volatility relative to the non-aromatic components. The solvent usually used in this process is phenol, but in special cases other solvents such as cresylic acids or sulfolanes may be preferable.

The flow diagram illustrates the application of the process to production of nitration grade benzine from a C_6 depentanized catalytic reformate. The original charging stock is first fractionated to prepare an aromatic concentrate.

The extractive distillation column consists of a knock-back section and an extraction section. The aromatic concentrate is charged at a point near the middle of the extraction section, and as in ordinary fractionation, vaporization heat is supplied in a reboiler, and the overhead vapors after condensation are partially returned as reflux to the column. The top product contains essentially all the non-aromatics including the olefins and diolefins and only a trace of solvent. The bottom product is a mixture of the aromatic and solvent. The constituents are separated in the solvent stripping column. The aromatic is distilled off as top product, and the solvent is recycled to the extractive distillation.

The loss of aromatic in the raffinate from the extractive distillation column need not exceed one percent of the raffinate stream. Loss of solvent is small; other than by mechanical leakage, solvent is lost through upset operation of the knock-back section in the extractive distillation column and of the stripping column.

Yields: The table shows a material balance (solvent-free basis) for producing nitration grade benzene from depentanized catalytically reformed C_6 naphtha.

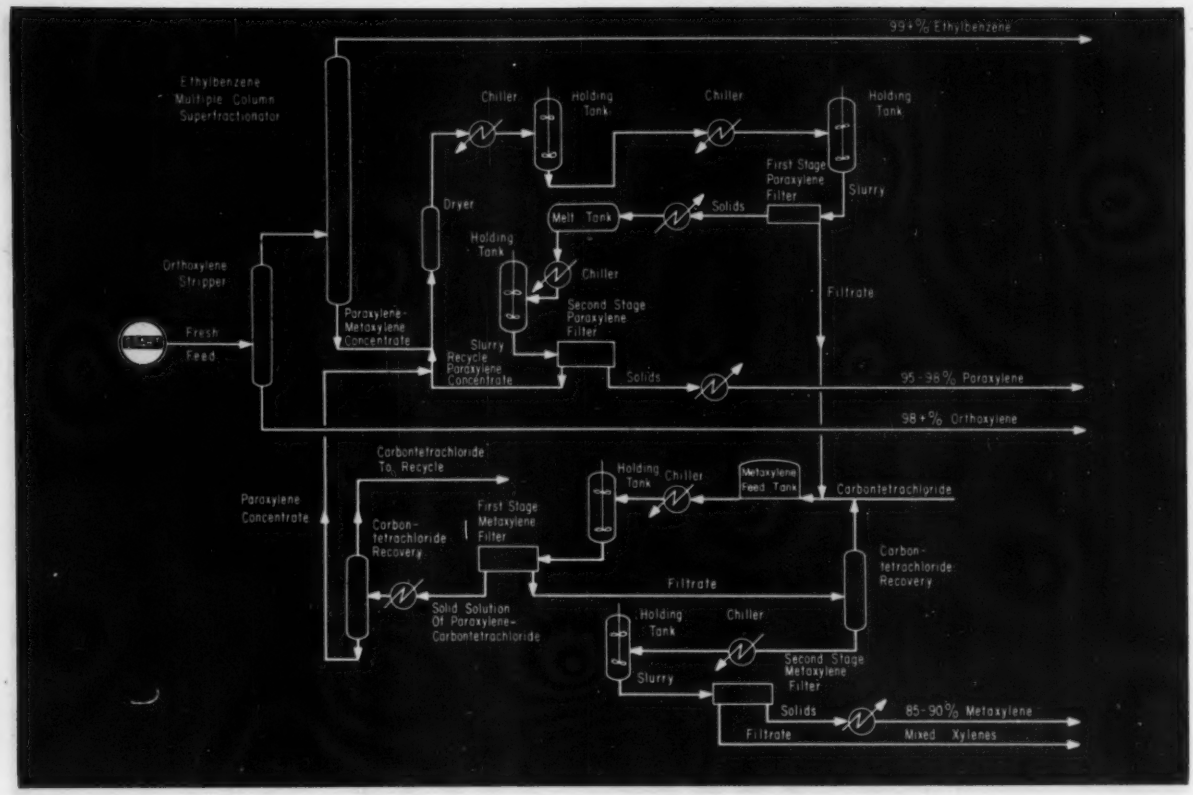
	Feed		Top Product		Bottom Product	
	Bbl./sd.	%v Benzene	Bbl./sd.	%v Benzene	Bbl./sd.	%v Benzene
Benzene Concentration	2214	45.9	2004	50.5	210	2.0
Extractive Distillation	2004	50.5	994	1.0	1010	99.2
Solvent Stripping	1010	99.2	1010	99.2	Solvent	
Redistillation*	1010	99.2	1000	99.5	10	.....

* After acid treatment and caustic wash.

Commercial Installations: The following plants are in operation or have been operated:

COMPANY	LOCATION	AROMATIC
1. Continental Oil Company	Ponca City, Oklahoma	Benzene, toluene
2. Pan American Refining Corporation	Texas City, Texas	Benzene
3. The Pure Oil Company	Toledo, Ohio	Toluene
4. Shell Oil Company	Wilmington, Calif.	Benzene, toluene and xylenes
5. Shell Oil Company	Wood River, Illinois	Toluene, xylenes
6. Standard Oil Company (Indiana)	Whiting, Indiana	Benzene
7. Atlas Oil Processing Company	Shreveport, Louisiana	Benzene
8. Shell Oil Company	Houston, Texas	Benzene, toluene
9. Standard Oil Company of California	El Segundo, Calif.	Benzene
10. Sinclair Refining Company	Marcus Hook, Pa.	Toluene
11. Gulf Refining Company	Philadelphia, Pa.	Toluene
12. Argentine Government	Campana, B.A., Argentina	Toluene

Reference: PETROLEUM REFINER, Sept.'52,p242.



Fractionation and Fractional Crystallization of Xylenes

Application: A generalized scheme for the production of individual C_8 aromatics to provide raw stocks for styrene (from ethylbenzene), polyethylene terephthalate (from paraxylene), phthalic anhydride (from orthooxylene), and isophthalic acid or esters (from metaxylene).

Charge: A narrow-cut 100 percent aromatic fraction from catalytic reforming with approximately the following composition:

Component	Weight Percent
Ethylbenzene	20
Paraxylene	20
Metaxylene	40
Orthoxylene	20

Products: 99+ percent Ethylbenzene, 95-98 percent Paraxylene, 85-90 percent Metaxylene, and 98+ percent Orthoxylene.

Description: The integrated process presented here describes recovery of all of the individual components in the xylene fraction in high purity. This was considered impractical until only a few years ago.

Compound	Boiling Point, F.	Freezing Point F.
Ethylbenzene	277.1	—139.0
Paraxylene	281.0	—55.9
Metaxylene	282.4	—54.2
Orthoxylene	291.9	—13.3

Since the greatest boiling point spread is between orthoxylene and metaxylene, orthoxylene can be stripped from the mixture by conventional fractional distillation to produce 98+ percent orthoxylene. The remaining mixed xylene feed is charged to the lower region of a superfractionator from which 99+ percent ethylbenzene is recovered as the overhead product. The difficulty of this separation is apparent from the boiling points of ethylbenzene and paraxylene. The separation requires approximately 350 plates and a reflux ratio of 60/1 to 100/1, depending on the final purity required.

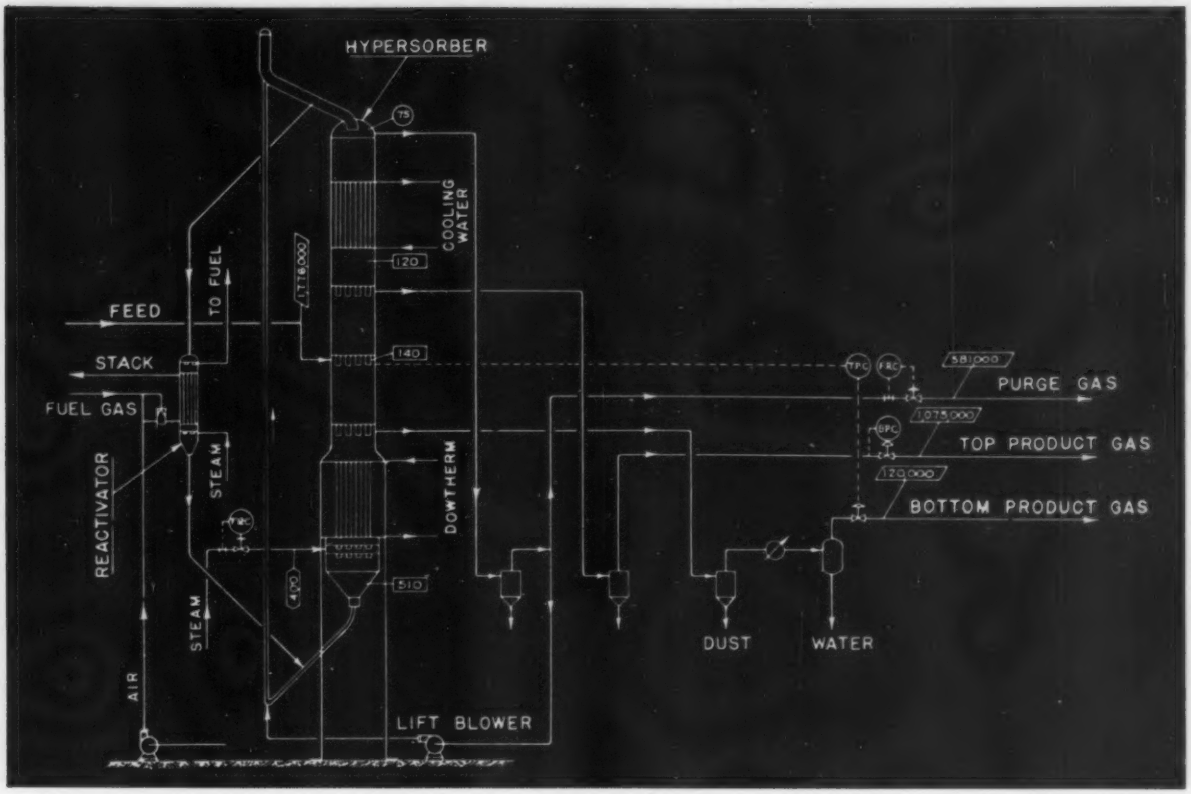
The superfractionator bottoms is subjected to low-temperature fractional crystallization for paraxylene recovery. The stream is cooled to a temperature of —40 to —70 F. and sent to a holding tank to form large paraxylene crystals. The step is repeated to a slightly lower temperature, and the crystals are removed by centrifugal filters to give an intermediate purity of 75 to 80 percent paraxylene. This product is melted, and cooled to 10 to 20 F. in a second concentration stage, held for crystal growth, and filtered to produce 95 to 98 percent paraxylene. The second stage filtrate, still rich in paraxylene, is recycled as feed. The first stage filtrate, enriched in metaxylene, is now processed by further fractional crystallization for metaxylene recovery.

Carbon tetrachloride forms an equimolal, solid molecular compound with paraxylene but not with the other xylenes. This facilitates recovery of incremental paraxylene and higher purity metaxylene. Equal volumes of carbon tetrachloride and metaxylene are mixed, cooled to around —100 to —110 F., and filtered. The solid complex stream is distilled for carbon tetrachloride recovery, and the paraxylene concentrate is combined with paraxylene feed. The paraxylene-free filtrate is distilled to remove carbon tetrachloride, and metaxylene is concentrated by further fractional crystallization at a temperature below —100 F. The solid cake now has a purity of 85 to 90 percent metaxylene. Mixed xylenes in the final filtrate may be used as a solvent, in motor fuel, or recycled to the optimum point in the process for further recovery.

Operating Conditions: The general operating conditions are indicated above. Temperature has a pronounced effect on formation of eutectics in the low-temperature crystallization steps.

Yields: Recoveries of individual components in their respective streams depends upon the extent of recycle in the several steps.

References: *Ind. Eng. Chem.*, **47**, 250-3(1955); *Ibid.*, 1096-1103.



Hypersorption—UNION OIL COMPANY

Application: Hypersorption is used for the separation of volatile hydrocarbons and other gaseous compounds. It is particularly applicable to the recovery and production of pure hydrogen, methane, acetylene, ethylene, and propylene.

Charge: The charge for this process is a gas stream which may be derived from natural gas operations, high temperature cracking operations on either liquid or gaseous hydrocarbons, or steam-methane reforming operations for the production of hydrogen.

Description: Feed gas entering through a distributor passes upward counter-current to the moving bed of activated charcoal. In its passage through the bed, the heavier compounds are adsorbed and retained on the charcoal. The top product gas, comprising the lightest constituents in the feed, disengages from the charcoal below the cooler and passes off through a cyclone. The charcoal passes downward below the feed point to the rectifying section where it contacts a reflux of heavy constituents, separated in the stripper which serves to liberate lighter constituents adsorbed on the downward-moving charcoal. A concentration of these latter constituents in the vapor phase results and if desired they can be disengaged as a side-cut product gas at a point between the feed and bottom product gas disengaging sections. As the charcoal flows past the bottom product gas disengaging section into the steaming section, it meets an upward flow of steam which liberates the adsorbed heavy components, and these flow upward either to return as reflux or pass out as bottom product gas from the Hypersorber.

The charcoal flows from the streaming section into the stripping section wherein it passes down through tubes which are heated by a circulating heat-transfer medium and through which steam is passed counter-current to the charcoal. The hottest point in the stripper is at the bottom of this section and subsantially all residual adsorbed material is removed during the passage of the charcoal through this zone.

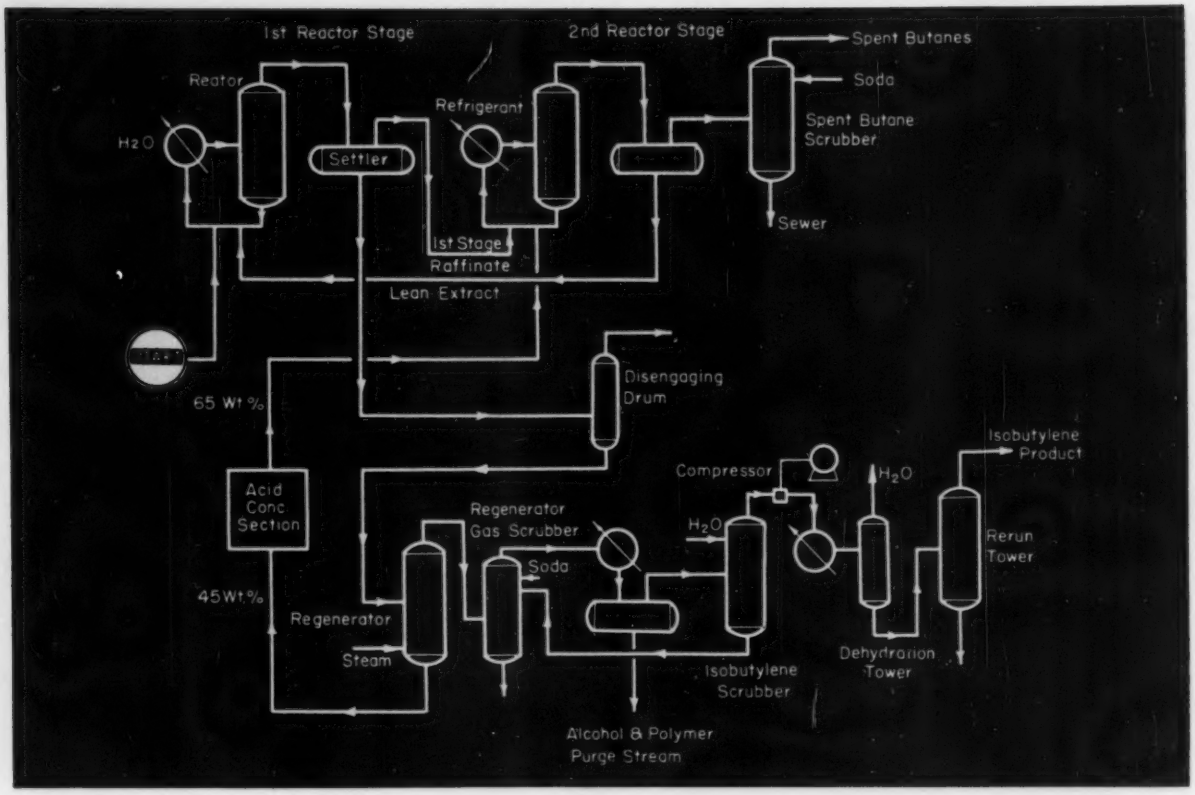
A charcoal regeneration unit, acting in parallel with the Hypersorber, carries out high temperature steam treatment of the charcoal to maintain its activity.

The charcoal is transported to the top of the tower by a gas lift system and is dropped into the reserve charcoal hopper at the top of the unit. The hot charcoal passes down from the hopper into the cooling section consisting of a tube and shell exchange wherein the charcoal is cooled to the desired temperature for adsorption.

Yields: The application of Hypersorption in the recovery of ethylene from a lean gas stream is shown, and the yields in a typical commercial operation are given in the table below:

COMP.	Feed Gas, Volume Percent	Bottoms Product, Volume Percent	Overhead Product, Volume Percent	Purge Gas, Volume Percent
Hydrogen	39.8	....	31.6	61.8
Nitrogen	1.7	....	1.4	2.5
Carbon Monoxide	0.9	....	0.8	1.3
Oxygen	0.1	0.1	0.1	0.2
Methane	51.3	....	66.1	33.7
Carbon Dioxide	0.2	2.9	....	0.1
Acetylene	0.2	3.6	....	....
Ethylene	5.8	92.7	....	0.4
Ethane	Trace	0.7	....	....
Total	100.0	100.0	100.0	100.0

Reference: PETROLEUM REFINER, Oct.'54,p153.



Isobutylene Extraction— ESSO RESEARCH AND ENGINEERING COMPANY

Application: A process for the extraction of isobutylene.

Charge: A stream containing 10 to 35 weight percent isobutylene, mixed with n-butylenes and varying amounts of saturated hydrocarbons.

Product: The product is 99 + percent purity isobutylene.

Description: The feed is charged to a two stage reactor-settler where it is contacted with 65 percent sulfuric acid. Maintaining the proper acid strength for the reactor section is important so that the acid does not absorb the other feed components to any appreciable extent. Isobutylene is selectively extracted in accordance with the following hydration reaction:

$$H_2O + \text{i-}C_4H_8 \overset{H_2SO_4}{\rightleftharpoons} \text{t-}C_4H_9OH$$

This reaction is highly exothermic and the temperature within the second stage reactor must be closely controlled by refrigeration to prevent excessive absorption of the other components.

The spent butanes are removed from the second stage settler and treated for other petrochemical or refinery uses. The isobutylene-acid extract is removed from the first stage settler and sent to the regenerator.

In the regenerator the isobutylene is stripped from the acid with steam. The acid, which has become diluted in the process, goes to a concentrator where its strength is built back up to 65 percent for recycle to the reactor section.

The regenerated isobutylene from the steam stripping operation is washed with caustic to remove traces of acidic impurities and to hydrolyze and then neutralize any esters that were formed in the process. Caustic washing is followed by water washing to remove any excess caustic.

Isobutylene from the water washing step is compressed, dried, and fed to a rerun tower where the high-boiling materials formed in the process are removed. The purified isobutylene is condensed and delivered to storage.

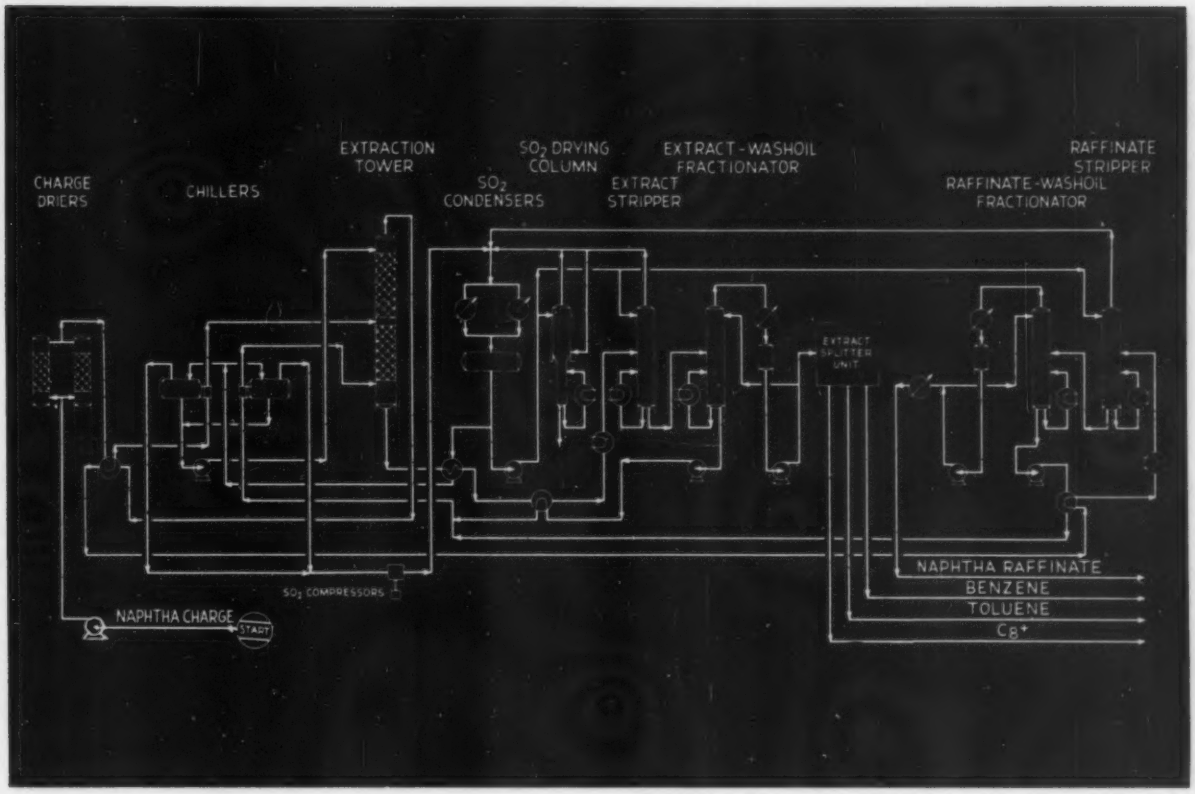
Operating Conditions: The major operating conditions are as follows:

Acid concentration for isobutylene extraction	65 percent
Dilute acid concentration from regenerator	45 percent
Lean extract, approximate saturation, mol $iC_4=$/mol H_2SO_4	0.5
Rich extract, approximate saturation, mol $iC_4=$/mol H_2SO_4	1.5
Recovery of isobutylene from feed	85 percent

Yields: Typical yields and analyses of the feed and products are as follows:

	Feed LV%	Spent Butanes LV%	Isobutylene Product LV%
Propene-propylene	2.0	2.3	——
n-butenes	28.0	31.9	0.4
Isobutylene	14.0	1.2	99.4
n-butane	23.0	26.1	0.1
i-butane	31.0	35.3	——
C_{5+}	2.0	3.2	0.1

Reference: PETROLEUM REFINER, May,'54,p156.



Modified SO_2 Extraction— STONE & WEBSTER ENGINEERING CORPORATION

Application: This process is applicable to the recovery of pure or highly concentrated aromatics from selected virgin naphthas, catalytic reformates, and heavier petroleum distillates.

Charge: Charge stock for this process can be any selected virgin naphtha containing aromatics, a reformate stream from a catalytic reforming unit, or a gas oil stream containing aromatics.

Products: In the processing of total reformates or of wide range virgin naphtha fractions, the process will simultaneously produce a highly concentrated benzene cut suitable for many industrial applications, nitration-grade toluene and a high-purity xylene and ethyl benzene fraction. If the benzene is to be nitration-grade, the process is supplemented by distillation facilities for final purification of this fraction. Typical purity and recovery of aromatics possible with such a plant are:

Aromatic	Purity	Recovery
Benzene	Nitration grade	98%
Toluene	Nitration grade	98%
C_8 Aromatics	90% plus	95-97%

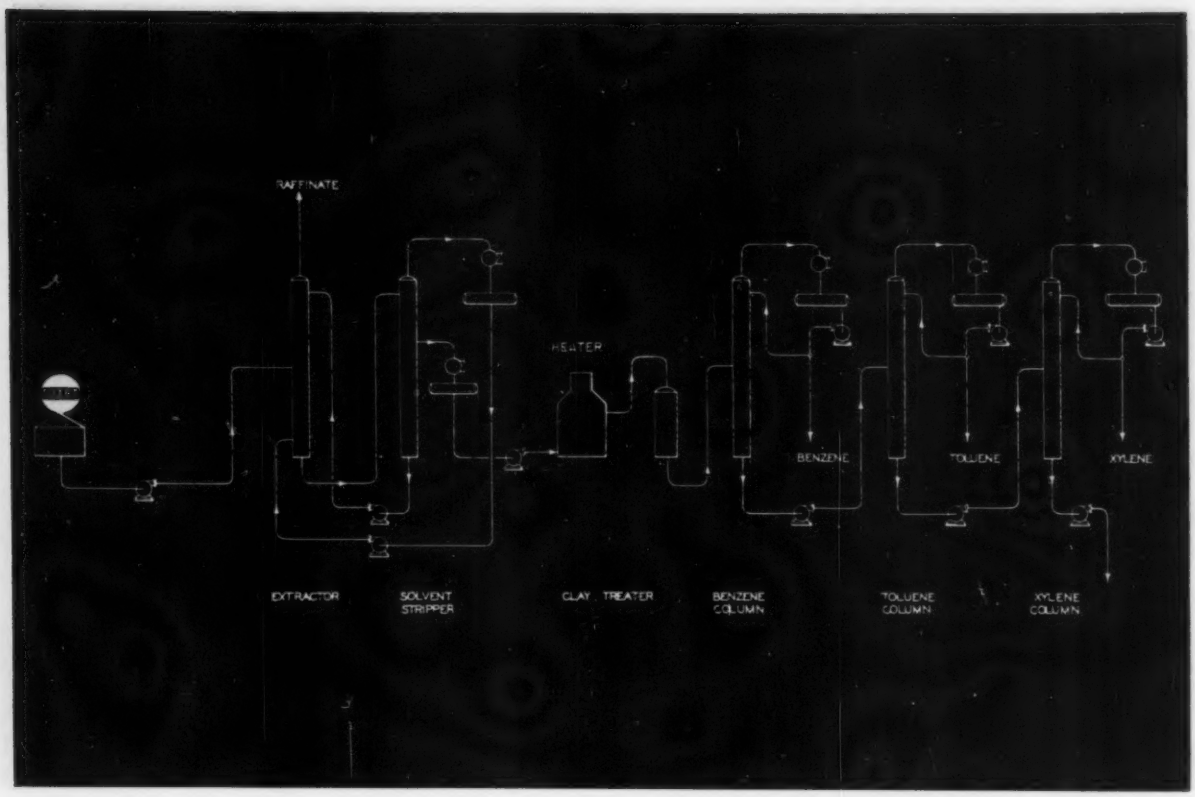
Description: The schematic flow diagram illustrates a plant for the recovery of C_6 to C_8 aromatics from a catalytic reformate. In this plant both the primary extraction of aromatics and the extract stripping are carried out at a temperature of —20 F. The liquid sulfur dioxide used for the extraction serves also as a refrigerant. The primary extraction of aromatics takes place in the upper half of an extraction tower equipped with packing or suitable trays and the extract stripping step is carried out in the lower half of that tower. The stripping agent, herein called wash oil, is a kerosine.

The charge stock, if containing appreciable water, is passed through driers. The charge stock is then chilled by cold SO_2 in a reboiler-type chiller before it is introduced into the center of the extraction tower. Cold liquid SO_2 from the chillers is pumped into the upper section of the extraction tower, while chilled wash oil enters the tower near the base. The contact of the charge stock with SO_2 and the stripping of the extract solution produces a raffinate phase containing the nonaromatic hydrocarbons of the boiling range of the naphtha, the bulk of the wash oil and some SO_2. The extract phase consists largely of aromatics and SO_2 and contains the remainder of the wash oil. The extractor operates under sufficient liquid pressure so that the two phases move to their respective recovery systems without intermediate pumping.

Operating Conditions: For the recovery of C_6 to C_8 aromatics from a reformate, an SO_2 rate of about 170 volume percent based on reformate charge is required. The wash oil rate will be 50 to 75 volume percent.

Commercial Installations: Five commercial units are installed.

References: PETROLEUM REFINER, Sept.1954,p230; PETROLEUM REFINER, May,1954,p151.



Udex Extraction— UNIVERSAL OIL PRODUCTS COMPANY

Application: The process uses an aqueous glycol solution to separate aromatics from other hydrocarbons.

Charge: Wide or narrow boiling range mixtures of petroleum oils containing benzene and higher aromatics.

Process Description: The heart of the process is an efficient multistage, countercurrent extraction column of special design which intimately contacts the feed with the solvent. Lean solvent, fed to the top of the column, selectively dissolves aromatic hydrocarbons, removing them from the bottom of the column in the rich solvent stream. The feed enters at an intermediate point of the extractor and a hydrocarbon "reflux" is introduced near the bottom. The non-aromatic portion of the feed—raffinate—is the overhead product of the extraction column.

Dissolved aromatics are stripped from the solvent in the next column, as a side-stream, hydrocarbon reflux also being separated as overhead product for return to the extractor. Water is recovered from both of these streams from the stripper upon cooling. Part of the water is used in a wash column to recover, for reuse, the traces of dissolved glycol contained in the raffinate and, sometimes, also to wash the extract. The remaining water is returned to the base of the stripper. The stripper operating conditions are so controlled that its bottoms product—lean solvent for return to the top of the extraction column—has the proper composition to effect the desired separation betwen the aromatic and non-aromatic hydrocarbons in the feed. The separated aromatic phase can be distilled in a train of three successive columns, respectively making pure benzene, toluene and C_8 aromatics as the overhead products. With good fractionation control, no intermediate cuts are necessary. The columns adjust automatically to wide variations in feed composition without deviation from product specifications. An outstanding feature of this process, in addition to its capability of handling wide boiling range mixtures, is that charge rates may be varied greatly without risk of upset at any point in the process train, or appreciable effect on the purity of the products.

Aromatics exceeding the purity requirements of the ASTM "Nitration Grade" specifications are produced consistently. Benzene of 5.4 C solidification point and other test specifications of comparable high purity are maintained. The toluene is of substantially equal purity.

Yields: The following tables give product properties and yields obtained in the commercial processing of a typical Platformate:

PRODUCT PROPERTIES	Udex Charge	Raffinate	Benzene	Toluene	Mixed Xylenes
Gravity, °API	51.9	76.4	.....	.....	.....
Specific Gravity, S. G. 60/60	.7715	.6806	.885	.873	.873
Percent Aromatics	51.3	3.5	99.9	99.8	99+
Solidifying Point °C.	.....	.....	5.49	.....	.....
Distillation	F.	F.	C.	C.	C.
IBP	150	145	79.7	110.2	*
50 Percent	210	170	80.1	110.8	
Dry Point	302	295	80.3	111.0	
Acid Wash Color					
Color of Acid Phase	.....	.....	0	0+	0+
Color of Hydrocarbon Phase	.....	.....	0	0	0+
Acidity, Mgs. NaOH/100 ml Sample	No Free Acid				
Copper Strip Corrosion	Passed				

* Ethylbenzene, 14.5 weight percent; p-xylene, 19.0 weight percent; m-xylene 42.0 weight percent; o-xylene, 24.5 weight percent.

YIELDS	Percent by Volume of Extract	Percent by Volume of Udex Charge	Percent Recovery In Extract
Benzene	15.3	7.6	99+
Toluene	42.5	21.2	98
Xylenes and Ethylbenzene	40.4	20.0	94
C_9 Plus Aromatics	1.8	0.9	75
Total Extract	100.0	49.7	....
Raffinate	....	50.3	....
Udex Charge	....	100.0	....

Commercial Installations: More than 20 Udex units are in operation, being designed or under construction at the present time. Design feed capacities range from 500 to 28,000 BPSD. The products range from blending components for high octane motor fuels to individual, high purity aromatic hydrocarbons.

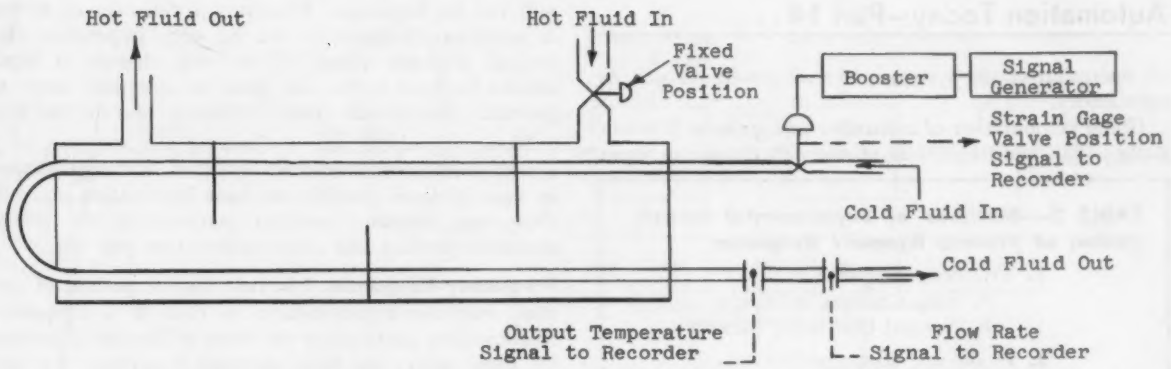


FIGURE 73—Here is one way to test the dynamic response of a heat exchange process.

Part 14

Automation Today

Be sure you are testing the right part of a control system. Here is a discussion of how to carry out experimental plant tests.

Theodore J. Williams,
Monsanto Chemical Company,
St. Louis

IN NEARLY every previous case, we considered the purely theoretical nature of process control. Now we will turn to the experimental aspects of our subject. First we will examine some of the methods of plant testing a control system. Next we will discuss how these tests are carried out. Then, in a later part, we will show how to treat the resulting data.

THE PLACE OF EXPERIMENTATION

In Part 11 we listed the disadvantages inherent in an entirely experimental approach to process control. At the same time we detailed the need for a certain amount of experimentation to verify the theoretical simulations we have made through the use of analog or digital computers or by analytical means. Such verification is necessitated by the assumptions which are normally made to reduce the complexity of the equations involved. We must, therefore, be certain that each assumption thus made is valid for the conditions under study; otherwise, our simulation will be not only useless but also misleading. In fact, it could possibly lead to damage of the apparatus in question if incorrect results so obtained are applied directly—hence our concern with verification of the main points of the simulation.

At the same time we should again reiterate our statement that an experimental test of the complete simulation or even of each piece of apparatus involved is not necessary. Once we have proven that a given assumption is valid for a certain type of apparatus under the given conditions, any further tests are wasteful of time and money if carried out experimentally.

Our first task, therefore, is to review the results of the simulation and to pick those sets of system parameters and input conditions which give responses which are most readily checked. Some particular points to look for are listed in Table 1.

TYPES OF INPUTS AND METHODS OF TESTING

Once we have decided just what points of our theoretical investigation will most appropriately and easily check our simulation results, our next step is to pick the best experimental method for our purpose. The possible methods are given in Table 2.

Transient Response. The simplest test to apply is that of the transient response. This is usually accomplished by causing a step change in one of the inputs to the system. It is especially valuable when checking the ability of a proposed automatic control configuration to control the system in question. This is because the step change of an input is the most severe disturbance to which the controller can be subjected. Thus if this upset can be controlled to the degree desired, the over-

TABLE 1—Points to Consider for Experimental Checking of Simulation Results . . .

1. Upper and lower limits of operating ranges to afford the quickest check of items such as heat transfer coefficients, et cetera.
2. Where the response of a system under automatic control is being checked, use those combinations of system and controller parameters which mark the boundaries between response regions, i.e., where simulation shows the response to be just oscillatory, sustained oscillation, et cetera (see Figure 56 of Part 9, PETROLEUM REFINER, March, 1957, p. 232).
3. Where frequency responses are being taken, check those frequencies which define the "break points" of the asymptotes of the Bode diagram (see Figure 27 of Part 5, PETROLEUM REFINER, August, 1956, p. 161) and those which mark any maximum and minimum points on the diagram.

all operation of the system under all conditions will be satisfactory.

If the combination of controller and process is essentially linear, the magnitude of the step change in input will not be important. However, if the over-all system is nonlinear, magnitude can be very important; and several different values of the step change in input should be tried to be sure that the complete range of probable operational upsets is covered during the test.

However, where one is checking the response of a system without a controller attached, the step change in input gives us possibly the least information per test. Frequency response methods, particularly the pulsed methods, produce the most information per test.

TABLE 2—Methods of Experimental Investigation of Process Dynamic Response

1. Transient Response
   - A. Step Changes in Inputs
   - B. Normal Operating Records
2. Frequency Response
   - A. Sinusoidal Inputs
   - B. Pulsed Inputs
   - C. Normal Operating Records

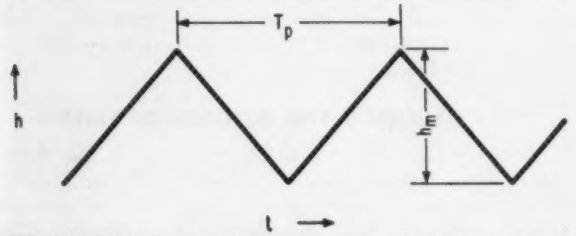


FIGURE 74—The repeated square pulse may be represented by the following Fourier series: $h = \frac{h_m}{2} + \frac{2h_m}{\pi}\left(\sin\frac{2\pi t}{T_p} + \frac{1}{3}\sin\frac{6\pi t}{T_p} + \frac{1}{5}\sin\frac{10\pi t}{T_p} + \ldots\right)$

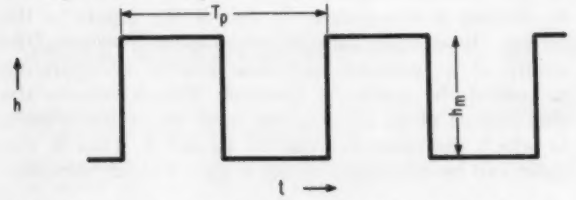


FIGURE 75—The Fourier series for triangular pulses is as follows: $h = \frac{h_m}{2} - \frac{8h_m}{\pi T_p}\left(\cos\frac{2\pi t}{T_p} + \frac{1}{9}\cos\frac{6\pi t}{T_p} + \frac{1}{25}\cos\frac{10\pi t}{T_p} + \ldots\right)$

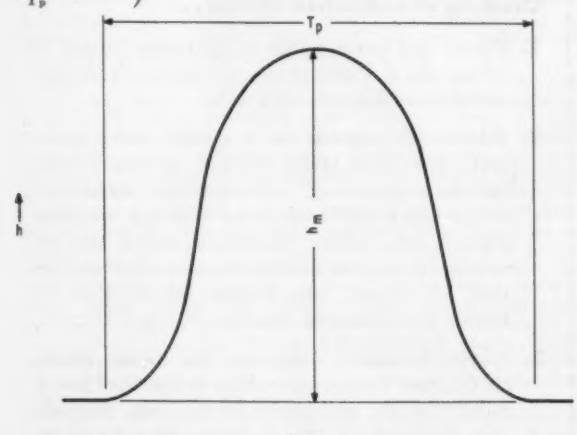


FIGURE 76—The displaced cosine pulse has the equation $h = h_m\left(1 - \cos\frac{2\pi t}{T_p}\right)$ **for** $0 < t < T_p$. **The value of h is zero for t's outside this range.**

Frequency Response. The best known method of systems response representation is that of a frequency response plot, particularly the Bode or Nyquist diagrams. Of these latter, the Bode diagram is perhaps the best known in process instrumentation and process control circles (see Parts 4, 5, and 6; PETROLEUM REFINER, July, August, and September, respectively, 1956).

The most straightforward method of obtaining the data necessary to produce such a diagram experimentally is to apply a series of sinusoidally varying upsets to one of the inputs to the process. These input variations must cover the range of frequencies which is important to the process. This usually entails a change of frequency of at least 1000/1 between the slowest and fastest oscillations involved. In addition, it will probably require 10 to 15 separate test runs to secure enough points to give a satisfactory diagram since each one will give us only the magnitude ratio and phase shift at the particular frequency in question.

Figure 73 shows a possible test system for a heat exchanger. The input disturbance is applied by a signal generator to the cold fluid control valve.

The frequencies of importance, however, in process control, particularly of plant scale equipment, are so low that an inordinate amount of time is required (often several hours) to complete each run since several cycles of oscillation should be used to assure that any transients have died out and that the true sinusoidal response is being obtained.

An easier and quicker method of testing is therefore needed. When one remembers that a square pulse, a triangular pulse, a displaced cosine pulse, or other such input can be represented by a Fourier series of multiple frequency components, a method for accomplishing this is at hand. If we can apply one of these pulses to our apparatus and determine the Fourier series or the Fourier transform of the input and of the output and compare the derived magnitudes and phases for each of the frequencies involved, we can obtain the data necessary for a frequency response from one experimental test.

Unfortunately, the retrieval of this data from the input and output records is a very complicated and tedious task, usually requiring the aid of a digital computer.

Figure 74 pictures the square pulse, Figure 75 shows the triangular pulse and Figure 76 illustrates the displaced cosine pulse. The latter pulse is used in a method originated by the Instrumentation Laboratory of MIT and described by Lees and Hougen.[6]

Another method of testing which has been recently proposed is that of a statistical study of normal operating plant records. This involves making auto-correlations and cross-correlations from fluctuations occurring in the

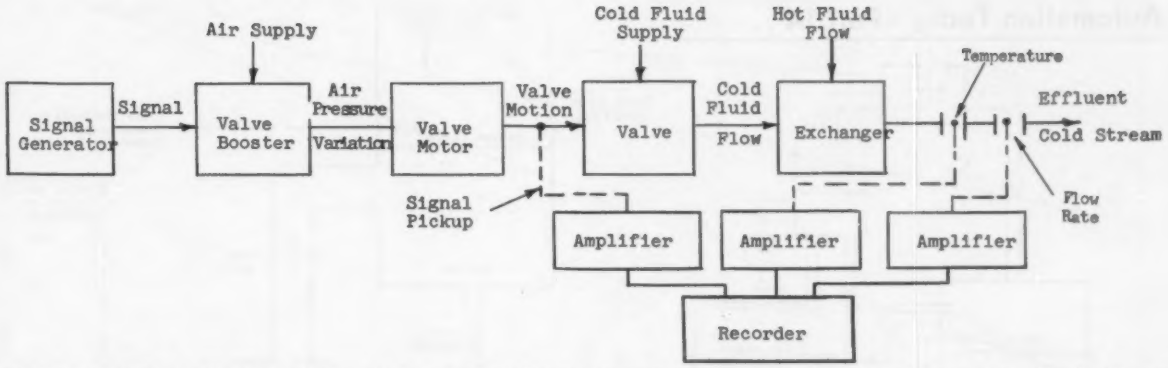


FIGURE 77—This is the block diagram for a system to find the frequency response of a heat exchanger. The signal will vary the amount of cold fluid permitted to pass through the exchanger.

plant records due to the normal day by day upsets or to natural noise in the system.[3,7]

While this method has the decided advantage of not requiring special tests of the process system in question, it has the disadvantage that usually only small magnitudes of input variation are involved and thus only a limited range of variables can be studied. In addition, due to the small magnitudes involved, a system may appear linear when actually it is not as we have mentioned before.

HOW THE TESTS ARE CARRIED OUT

Since our purpose in testing a particular apparatus is to apply a known disturbance to an input to the process and record the resulting effect upon the system output, let us study some examples of how this may be accomplished.

If one wished to test the heat exchange system which we discussed in Parts 9 and 13, he might proceed as follows:

Figure 73 shows a possible test of the system without a controller. Here we must make a frequency response test either with sinusoidal signals or one of the pulse methods. The input disturbance is applied by causing the signal generator to vary the air supply to the cold stream input valve through a booster valve in conformance to the desired signal. Input to the booster from the signal generator may be either mechanical or pneumatic. There are several companies which manufacture devices for carrying out this part of the test.

Figure 77 shows the block diagram for this system. We may record the valve position by means of the signal from a strain gage mounted on the valve stem. This, along with the simultaneous variations in cold stream flow rate and cold stream outlet temperature, is the data we need for our subsequent analyses. Transducers are available commercially to permit accurate determinations of liquid flow variations of nearly any magnitude, and amplifiers are available to record strain gage and thermocouple readings directly on recorders.

If a controller is included in the system as in Figure 78, the most common test which is applied involves changing the set point of the controller, either through a step change if transient response is desired or sinusoidally if frequency response is our aim.[2]

Figure 79 details a much more complete system for testing the heat exchanger under automatic control conditions. This essentially amounts to a combination

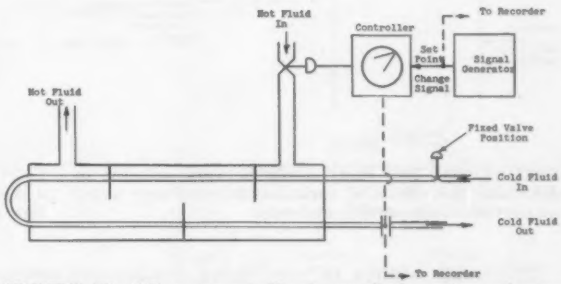


FIGURE 78—When a controller is attached to the exchanger, this system can be used to change the set point.

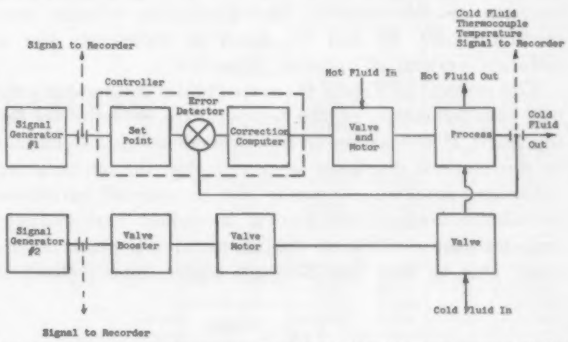


Figure 79—Two generators are used in this test system. This essentially is a combination of the tests of Figures 73 and 78.

of the tests of Figures 73 and 78. Two signal generators are provided. One which varies the set point of the controller permits variations in shell side fluid flow (hot fluid) without a corresponding change in tube side flow (cold fluid). The other varies the cold fluid flow rate and (since the controller is attached) causes a corresponding variation in hot fluid flow. Thus tests can be made of the possible effects of the heat transfer coefficient upon the controllability and response of the heat exchange system.

The presence of the two signal generators permits testing the control system under the most severe conditions possible, a step increase in cold fluid flow rate and a simultaneous increase in cold fluid output temperature set point. If the controller and hot fluid valve are sufficient to handle this disturbance, all other inputs to which the exchanger may be subjected can be adequately handled.

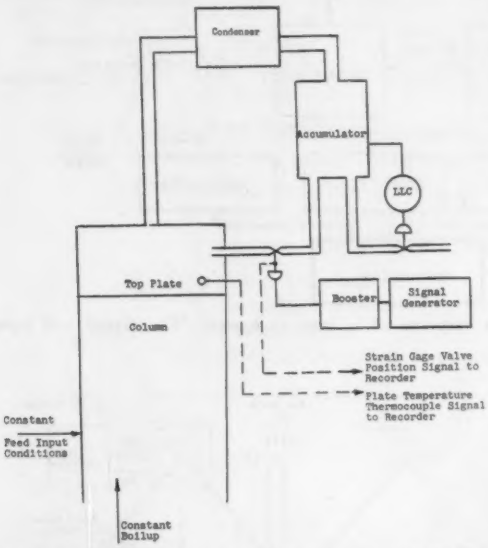


FIGURE 80—This study would be very valuable to determine the effects of variations in condenser water on operation of a partial condenser.

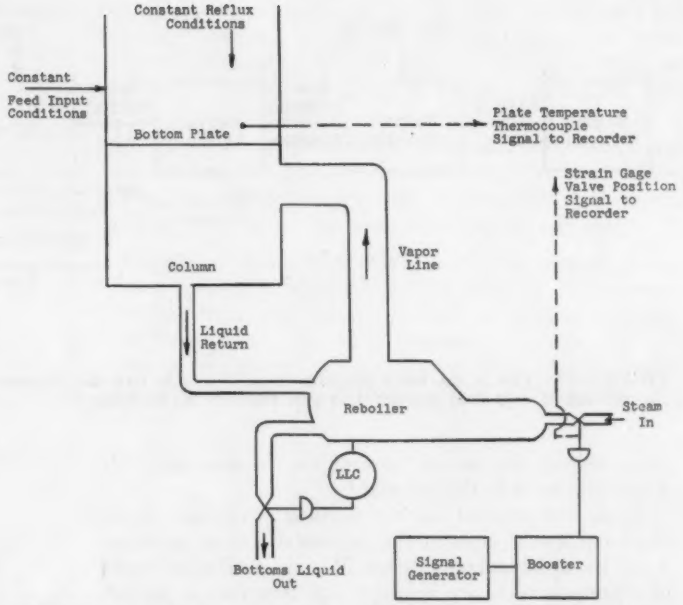


FIGURE 81—A similar test may be performed on the bottom section of a distillation column. This test could pinpoint the effect of reboiler steam flow upsets on the column control.

One must always be sure when conducting system response tests that he is actually testing those parts of the apparatus in which he is really interested. As an example of this, consider the distillation column tests of Figures 80, 81 and 82. Each of these can give a different version of column dynamics.

The system[1] of Figure 80 connects the column into the test loop by means of the temperature detector on the top plate. If one wishes to test over-all column dynamics by this method, one must be certain that the temperature variations detected are really due to over-all variations in column composition caused by reflux rate changes and not just short term variations in top plate conditions. Due to flow lags between plates, high frequency variations can occur on the top plate which are not transmitted to the lower sections of the column.[8] Thus an erroneous frequency response may be obtained unless care is used. On the other hand, there are upsets which could occur where top plate response would be important (such as variations in condenser water flow when a partial condenser is used) and such a study as this would be very valuable. Thus our statement that one should be sure he is testing for the actual data desired.

Similarly the test of Figure 81 which is derived from one proposed by Day[4] gives the corresponding tests for the column bottoms to that just described for the top of the column. This test will pinpoint the effect of steam flow upsets. However, because of the usual large time lags involved in heat exchange systems, there is much less concern that the full column dynamics will be taken into account by this test, as compared to that of Figure 80.

Complete column dynamics can only be assured when the complete column is in the test loop. Thus, as Figure 81 shows, a feed input disturbance in composition or rate or both when compared with the corresponding tops and bottoms output compositions will define completely the column response.[5,9]

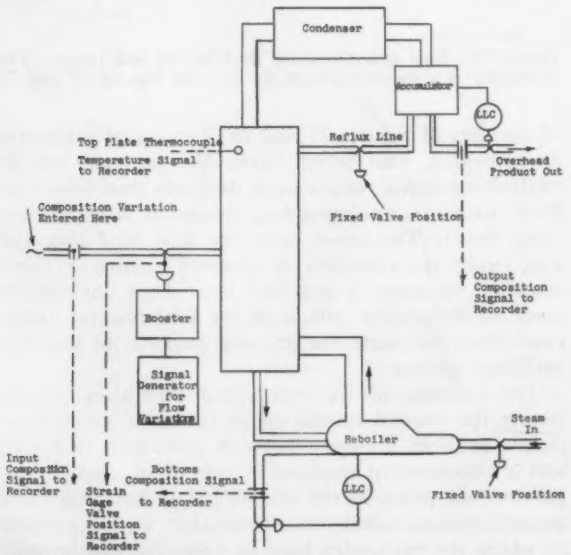


FIGURE 82—Complete column dynamics can only be assured when the complete column is in the test loop.

Part 15 will appear in an early issue of PETROLEUM REFINER.

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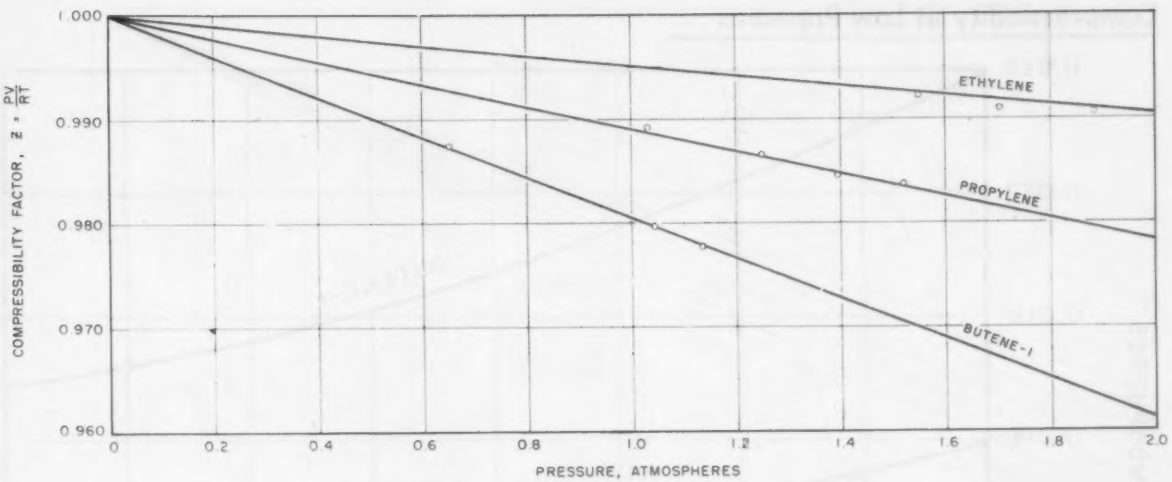

FIGURE 1—Compressibility factor vs. pressure at 120 F.

Compressibility Factors at Low Pressures

Here are experimental data for ethylene, propylene and butene-1 up to two atmospheres pressure.

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The University of Texas
Austin, Texas

THE LITERATURE contains very little information on the compressibility factors of ethylene, propylene, and butene-1 below two atmospheres pressure. The deviation of these gases from ideality is quite small at low pressures and in many calculations this deviation may be neglected, but for precise work, the compressibility factors must be known.

The PVT behavior of ethylene, propylene, and butene-1 was studied, using a gas density balance at 90, 120 and 150 F. for a pressure range extending from 400 to 1500 mm of mercury.

Apparatus and Procedure. An Edwards-type gas density balance[1, 11] was used in this investigation. Edwards[2] reported the accuracy of this balance to be at least 0.2 percent. Other in-

TABLE 1
Determination of the Best Straight Line

Temp. °F	Gas	Pressure atm.	COMPRESSIBILITY Factor	COMPRESSIBILITY Percent Error	Virial Coefficient
90	Ethylene	1.2305	0.9923	—0.08	0.00626
		1.6135	0.9907	—0.02	0.00576
		1.4687	0.9914	+0.03	0.00586
		1.1904	0.9943	+0.10	0.00479
		1.7862	0.9903	+0.03	0.00543
	Average			±0.05	0.00562
90	Propylene	0.8180	0.9895	0.00	0.01284
		1.3212	0.9827	—0.03	0.01309
		1.4404	0.9815	0.00	0.01284
		0.9743	0.9866	—0.09	0.01375
		0.7906	0.9907	+0.09	0.01176
	Average			±0.04	0.01286
90	Butene-1	0.7084	0.9804	—0.03	0.02455
		0.9844	0.9761	—0.01	0.02428
		1.0733	0.9750	+0.08	0.02329
		0.7278	0.9824	—0.01	0.02418
	Average			±0.03	0.02408
120	Ethylene	1.7039	0.9910	—0.09	0.00528
		1.5506	0.9923	—0.03	0.00497
		1.2572	0.9952	+0.12	0.00382
		1.8843	0.9905	—0.05	0.00504
	Average			±0.07	0.00478
120	Propylene	1.3962	0.9845	—0.05	0.01110
		1.5223	0.9836	—0.01	0.01077
		1.0305	0.9893	+0.04	0.01038
		1.2511	0.9866	0.00	0.01071
	Average			±0.03	0.01074
120	Butene-1	0.6469	0.9876	+0.01	0.01917
		1.0422	0.9797	—0.01	0.01948
		1.1352	0.9778	—0.02	0.01956
	Average			±0.01	0.01940
150	Ethylene	1.3708	0.9929	—0.15	0.00518
		1.3231	0.9951	+0.06	0.00370
		1.6337	0.9934	+0.01	0.00404
		1.9834	0.9918	0.00	0.00413
		0.8763	0.9923	0.00	0.00410
	Average			±0.04	0.00412
150	Propylene	0.9173	0.9919	+0.01	0.00883
		1.4711	0.9857	—0.10	0.00972
		1.6042	0.9852	—0.02	0.00923
		1.0863	0.9909	+0.08	0.00838
		1.3177	0.9879	—0.01	0.00918
	Average			±0.04	0.00907
150	Butene-1	0.6814	0.9880	—0.09	0.01761
		0.8943	0.9854	0.00	0.01621
		1.1004	0.9829	+0.09	0.01554
		1.1981	0.9809	+0.05	0.01594
	Average			±0.06	0.01633

* Mr. Pfennig is now with Merichem Company, Houston.

Compressibility at Low Pressures . . .

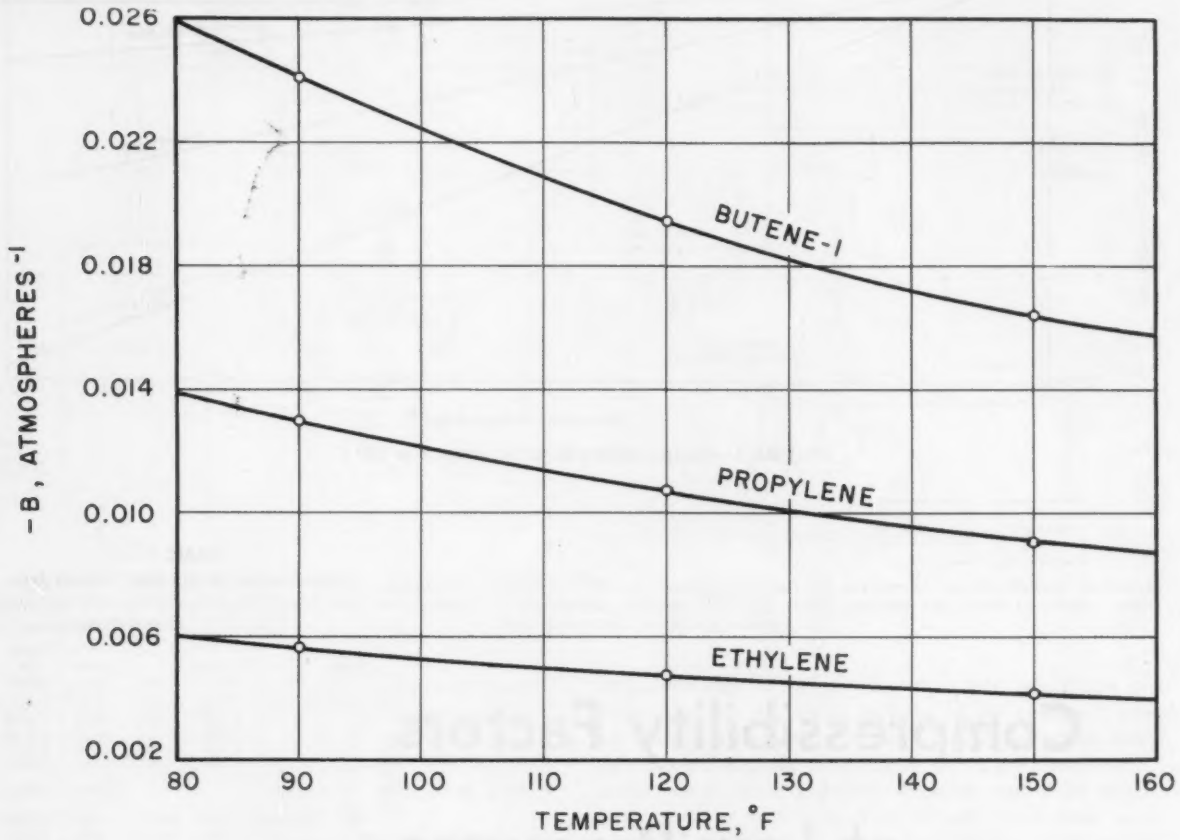

FIGURE 2—Virial coefficients β vs. temperature.

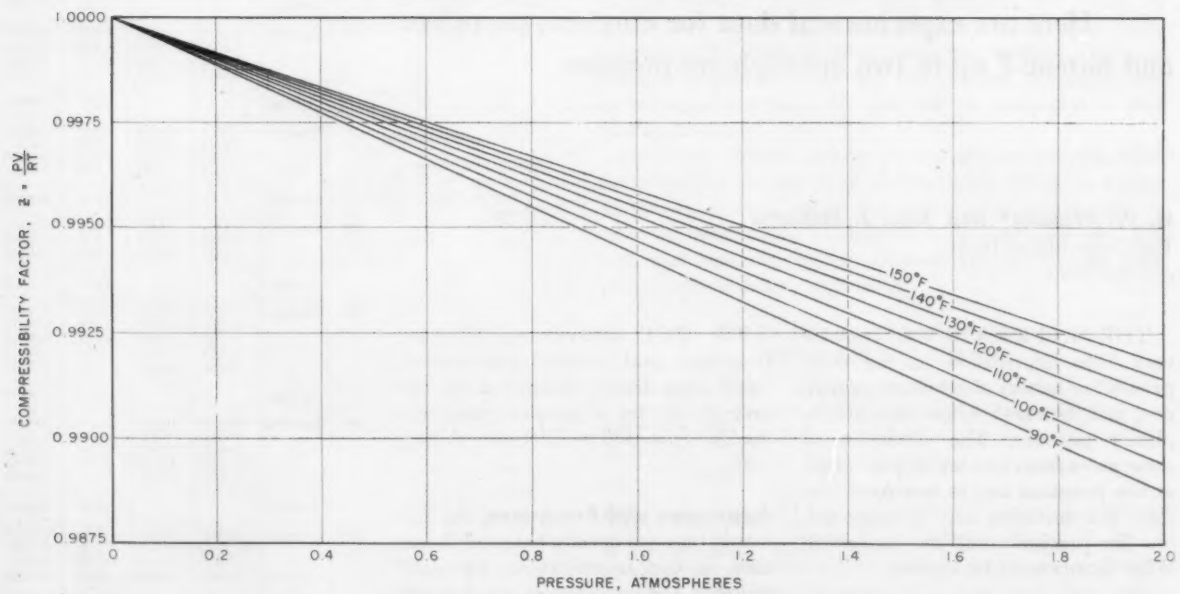

FIGURE 3—Compressibility isotherms for ethylene.

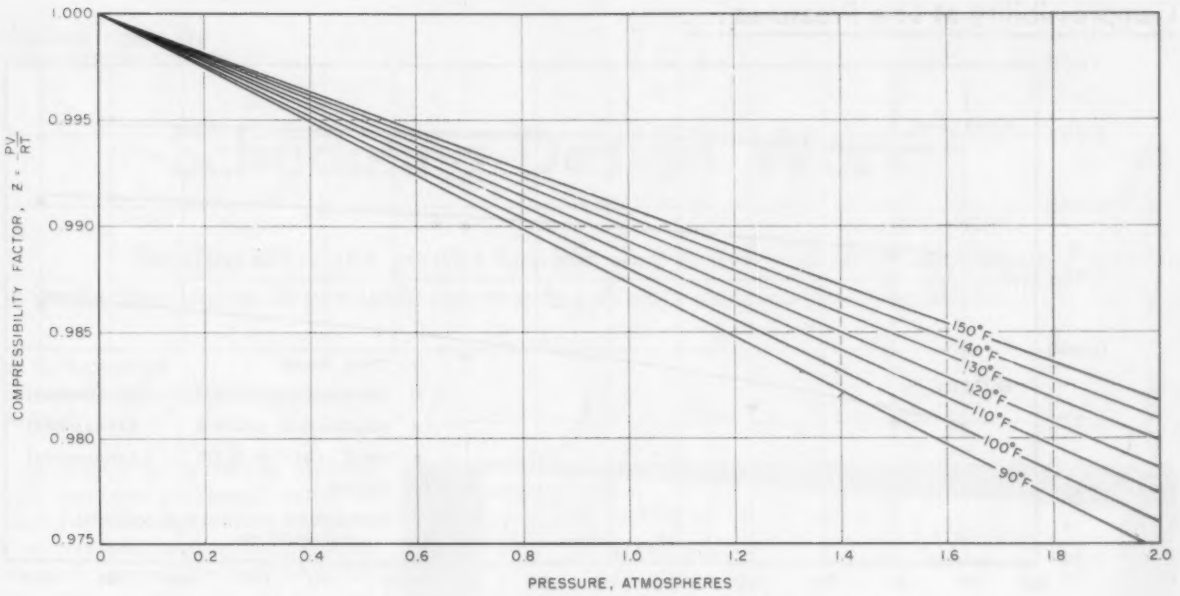

FIGURE 4—Compressibility isotherms for propylene.

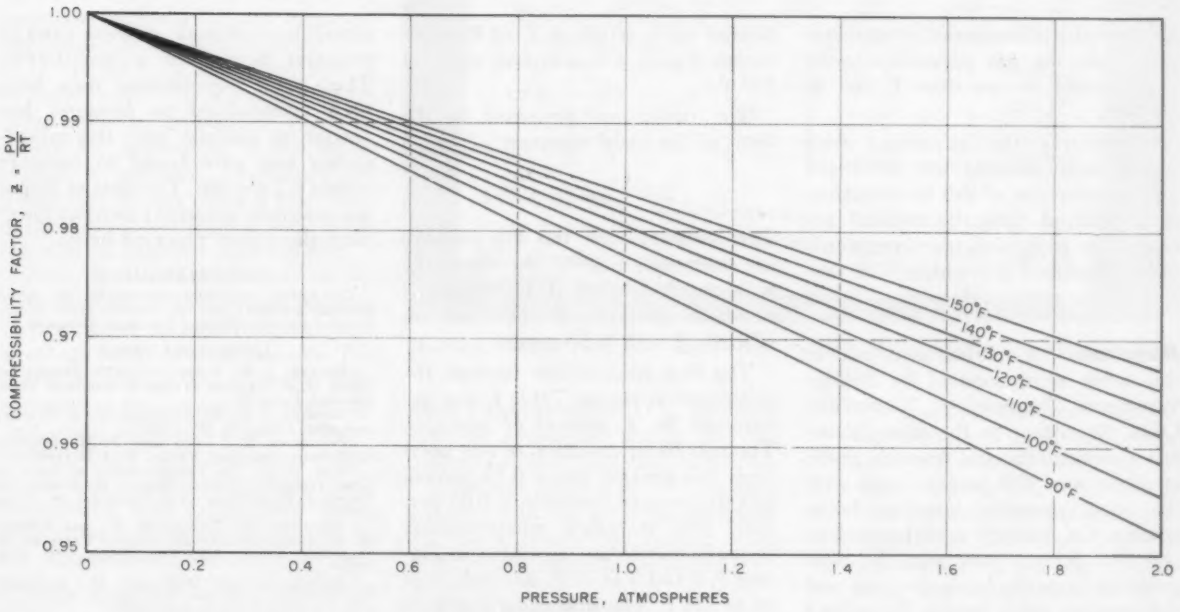

FIGURE 5—Compressibility isotherms for butene-1.

vestigators using this same type of balance reported accuracies of 0.2 percent and better.[4,10,11,12] The apparatus is a constant volume unit so the only variables to be measured were temperature and pressure. The accuracy of the investigation therefore depends primarily on the accuracy of the balance itself and the technique and precision of the operator.

The temperature was measured to within 0.1 F. and corrected to the desired experimental temperature by multiplying by the appropriate temperature ratio. The errors introduced into the final results from errors in temperature measurements were estimated to be less than 0.04 percent.

The pressures were measured by means of mercury in glass manometers. The heights of the mercury legs were measured, using a cathetometer, with an accuracy to the nearest 0.01 mm. The maximum error which could have been introduced into the final results by errors in the pressure measurements was 0.015 percent.

The same balance was used for all gases in a series of readings. Before each gas was tested, the balance was purged twice by evacuating the system and then filling to atmospheric

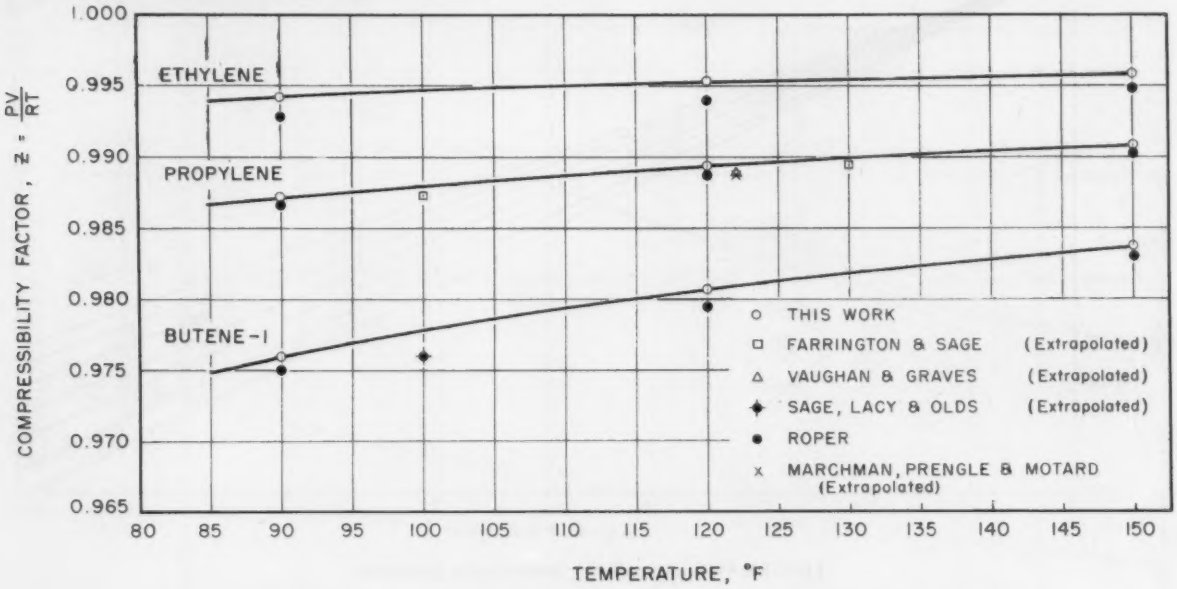

FIGURE 6—Comparison of compressibility factors with other investigations (Pressure = 1 atmosphere).

pressure. In this manner, contamination from the gas previously tested was reduced to less than 1 part in 100,000.

Considering the accuracy with which each variable was measured and the precision of this investigation, it is believed that the over-all accuracy is such that the compressibilities reported are within 0.10 percent of the actual value.

Materials. All hydrocarbons used in this work were donated by Phillips Petroleum Company of Bartlesville, Okla. According to the manufacturer's specifications, the research grade ethylene was 99.9 percent pure with the most probable impurity being ethane, the research grade propylene was 99.7 percent pure with the most probable impurity being propane and the research grade butene-1 was 99.5 percent pure with the most probable impurity being iso-butene. A mass-spectroscopic analysis of the Argon used showed this gas to be 99.89 percent pure with the impurities being 0.01 percent oxygen and 0.10 percent nitrogen. No further effort was made to purify any of these gases since the error introduced into the final results by these impurities would be negligible.

Experimental Data and Results. The experimental data were first plotted on a series of Z vs Pressure charts. Figure 1 is a typical chart at 120 F.

The results are presented in the form of the virial equation

$$Z = 1 + \beta P + CP^2$$

The isotherms over this low pressure are essentially linear;[8] therefore, the virial coefficient C is O. Figure 2 shows the variation of the virial coefficient β with temperature.

The best straight line through the experimental points, Table I, was determined by a method of averages. The maximum deviation of any point from this straight line is 0.15 percent and the average deviation is 0.05 percent. The smoothed compressibility factor isotherms are presented in Figures 3, 4 and 5 at 10 F. intervals from 90 to 150 F. The smoothing was done by drawing the best curve through experimentally determined points on a compressibility factor against temperature plot, at a constant pressure of one atmosphere.

In Figure 6 is shown the comparison of these data with other investigations. Compressibility factor determinations were made by Roper[8] for these same gases and at pressures below two atmospheres. Vaughan and Graves,[13] Marchman et al,[5] Farrington and Sage,[3] Sage et al[9] and Michels et al[6,7] reported work on the compressibilities of some of these gases at pressures below ten atmospheres. These later experimental data have been extrapolated to pressures low enough to compare with this investigation and were found to compare within 0.2 percent. The data of Roper are generally about 0.1 percent lower than the values reported here.

ACKNOWLEDGMENT

The authors gratefully acknowledge the initial financial assistance and the research grade hydrocarbons given by Phillips Petroleum Company.

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Reduce costs by . . .

Scheduling Design Work

Detailed schedules predict location and activity of M&C employes. Program is ineffective unless dependable engineering design information is available.

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Humble Oil & Refining Company,
Baytown

IN RECENT YEARS, industry wide attention has been focused on ways for reducing refinery maintenance and construction costs. One of the most promising actions taken has been the establishment of planned maintenance and construction programs, detailed schedules which predict the location and activity of every company maintenance and construction employee for each working day. It is axiomatic to state that such a program cannot be effectively established unless a dependable source of supporting engineering design information is available. Experience has shown that for every 8 to 10 mechanics engaged in construction work there must be an engineer in the office.

Firm dates for the release of designs must be established and adhered to if planned maintenance and construction is to function properly. For example, tardiness of design-work completion on a catalyst-cracking-unit could result in a delay of downtime and the consequent rearrangement of the refinery operating plan. Engineering design finds itself in the position of holding the key to answers for management questions such as: "When can the facilities for producing product 'X' be completed? When can this new unit be in opeartion?" Many times the question is phrased another way; "We must have engineering on the job completed by—. Can you do it? If not, what will have to be delayed to do so?" To answer these questions, it is imperative that engineering design completion dates be predicted accurately.

It is conceivable that potential customers can be lost if design completion dates are not realistic. An accurate and reliable timetable for engineering design is vital to the whole refinery operation.

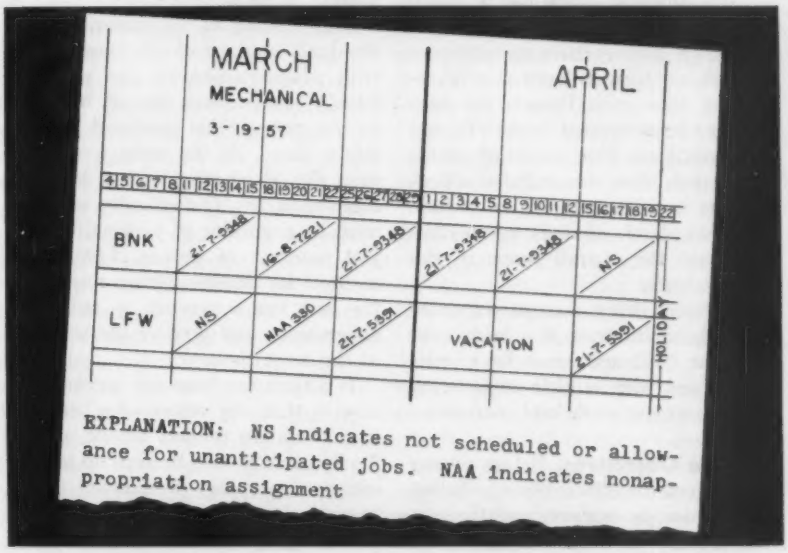

FIGURE 1—This form gives an up-to-date picture of individual and group work loads.

Here's the Problem. The establishment of a schedule for engineering design work in a large modern refinery is a problem which is likely to be more complex than any other problem confronting a design department. Some of the factors contributing to this complexity are:

- A large number of projects must be worked on concurrently. At times there may be as many as 200 separate projects to be scheduled. In some cases, these may be subdivided so that as many as ten or fifteen separate completion dates are required for various parts of a single project.
- There is great variation in the scope and nature of the projects. Sizes of jobs can range from the installation of a single pump or instrument to construction of a multi-million dollar process unit. Many projects consist of additions and alterations to existing process units and must be closely coordinated with plant operations. Trouble shooting, pre-estimate engineering and miscellaneous services add to the overall problem. And finally, the relative amounts of mechanical, civil, electrical and instrument engineering vary greatly with individual projects.
- The relative urgency of projects is continually changing. In refining, as in any other business "the customer comes first" and the refinery's many customers have changing needs in terms of new products, new specifications and in quantities desired. These needs of the customer can quickly transform a project of low priority into one of vital urgency. Another

factor influencing schedules is the minor change in process unit operations which often produces unanticipated corrosion, erosion, vibration damage or other forms of mechanical deterioration which must be given immediate engineering attention.

- Refinery process technology is advancing rapidly and in many cases newly discovered or newly conceived ideas must be incorporated after mechanical design has been planned and initiated. Although cutoff dates may be established for submission of process design, a progressive management will not turn its back on a lucrative idea even though the idea may be submitted late and upset timetables. The potential profits of such ideas demand that schedules be rearranged to include them. Such changes usually increase the overall scope of design work.
- Refinery design manpower is usually maintained at a fairly constant level and must be supplemented with outside engineering help as the work load increases.

Schedule Objectives. Before setting up a system for effectively scheduling refinery design engineering, the desired features of such a plan should be clearly established. One of the primary aims of the plan should be to set definite goals in terms of completion dates and establish the corresponding man-day requirements. This information should be systematically communicated to and accepted by all members of the team, draftsmen, design engineers, project engineers, maintenance and construction people and management, if the goals are to be attained. Responsibility for attainment of these goals must be clearly established. It is also essential that the people who will actually be performing the work be consulted when dates are being set as there is an almost universal repulsion to deadlines which appear to be arbitrary.

The making of assignments to individuals must be closely intermeshed with preparation of the schedule. Ideally, assignments should be made to the people best qualified for the job at hand. At the same time, each man should be employed to his optimum capacity. The effective schedule must be cognizant of personalities not just numbers of people. The logical method for accomplishing this is for the first line supervisor to make the assignments and prepare the schedule at the same time.

It is apparent from the previous discussion that any system of scheduling in the modern refinery should also be flexible, and should be kept up to date without usurping productive design time. A system with too much inherent complication can cause a design department to "schedule itself into a corner." Simplicity is mandatory.

Lastly, any plan of scheduling should have integrity. Over-all work loads of individuals and of different groups should be shown in such a manner that comparisons can be made readily. A properly conceived plan can be of great assistance to upper levels of supervision in seeing that there is equal sharing of work load between different groups as well as between individuals. The schedule should serve as an auditing device to insure that one particular design group is not "burned out" while another builds a "little empire."

Forming a Schedule. One of the first steps in formulating a schedule is to establish job priorities. This is a function of management and is largely governed by the policies of the company. One logical manner of arranging jobs in order of their relative urgency is as follows:

1. Safety items: Items which constitute potential hazards to life and property.
2. Customer satisfaction items: Facilities to produce new products or to meet new product specifications which must be completed in the immediate future.
3. Process unit downtimes.
4. Employe relation items: Projects to maintain good will of employes.
5. Research projects.
6. Pre-estimate engineering: Design work which is necessary in order to define the scope and cost of projects for management evaluation.
7. Other approved appropriations.

APPR'N NO.	TITLE AND STATUS:	MANDAYS SPENT REMAINING	ENGINEER
21-7-9348 A-D Rel. E - 4/8 4/15* Fx - 6/1	ADDITIONAL REHEAT CIRCUIT, HYDROFORMER 1. Work on pkg. E (Overhead piping & Platforms) in progress. 2. All materials requisitioned. *11. Pkg. E delayed to work on Appr'n. 16-8-7221	680/640 BNK 15 M 5 BEW 3 E 1 JRD 4 I 2 TJH 15 C 5 CEH 30 D 5	WSD BNK 53

EXPLANATION: Letters appearing under Appr'n. No. refer to complete portions or packages of the project; for example package "E" covers overhead piping and platforms. Package A through D have been released to field. The manday fraction 680/640 indicates that 640 MD was the original estimate and as of March 19 it appeared that 680 MD total would be required to design the project. The item BNK 15 M 5 indicates the initials of the mechanical engineer assigned to the project and that 15 mandays of productive work and 5 days of follow-up remain to be performed. Similarly initials E, I, C and D refer to electrical, instrument, civil and drafting. WSD is the project engineer and BNK is the lead designer. The number 53 is the priority.

FIGURE 2—A two-weeks summary of each design project is shown on this form.

In determining the relative urgency of approved projects which do not specifically fit in categories 1 through 6 above, the annual return, the size of the job and the elapsed time since approval should be taken into account.

After priorities have been determined, the estimation of design man-day requirements is in order. This can be best accomplished by joint action of the first line supervisor and the engineer who will be performing the design work.

To determine this figure, each job should be evaluated and a rough analysis of the required design steps should be made. The number of drawings to be prepared, complexity of design, estimated project cost, firmness of process design and availability of supporting information such as manufacturers drawings must be considered. Priority, man-day figures on past experience and even the people who will be involved, should also be taken into account. It is emphasized that accurate man-day records should be maintained for guidance in making future estimates and as a check on jobs which are in progress. Correlations between engineering man-day requirements and total job costs can be helpful as general guides, but they should not be relied on to the exclusion of the several considerations listed above.

The third step in establishing a schedule is to apply the priorities and man-day requirements of the projects at hand to the available design manpower. At first examination, this would seem to be a matter of simple arithmetic, but unfortunately, this is not the case. The effective schedule must, at this stage, take into account the nature and complexity of the job, the work load and capabilities of available designers and the other objectives previously discussed.

Our company has developed two complementary tools to meet these requirements. One of these is a semi-graphical form which plots each man's work assignments against the calendar. Figure 1 shows the general arrangement of this form. Each horizontal line is assigned to one individual and work assignments are plotted directly on the form. Holidays, week ends, and a reasonable allowance for unanticipated jobs are excluded from each man's available time. To make the form more accurate all other non-productive time such as vacations and substitutions in other departments is also plotted as soon as this information is known. The first line supervisor is responsible for maintaining this schedule sheet on a current basis for his group. At two-week intervals a revised copy of the schedule is published and distributed to all interested groups. The form is thus an accurate and up-to-date representation of individual and group work loads. It is an important aid to the immediate supervisor in making assignments and in establishing completion dates.

The second tool is a printed form which summarizes the status of design and drafting on all active projects. Figure 2 shows the general arrangement of this form. This sheet reflects, for each project, the design completion date, highlights of status, total man-days expended, original estimated man-days and a man-day analysis in terms of the various design groups involved. It also serves as a directory to indicate which designers are assigned to the job from different groups. In the event that the completion date must be changed or if there is some delaying element, that information is also reflected on the status sheet. Maintenance on a current basis is the joint responsibility of the lead designer and the first line supervisor. This form is brought up-to-date at two week intervals to coincide with the schedule-form revisions and copies are regularly distributed to all interested parties. The schedule-form serves as a check on the status sheet since man-day requirements and completion dates must be compatible with the time actually available as indicated on the schedule-form.

This system has been in the process of evolution for several years. It is believed that it meets most of the requirements of a sound scheduling plan. With the exception of the preparation of man-day estimates, almost all the work of maintaining the schedules is performed by supervisory and clerical personnel. Therefore, a minimum of productive design time is spent in scheduling. Although there is still room for improvement, accuracy in prediction of completion dates is showing a continuing upward trend. It is our belief that as more experience is gained it will be possible to accurately predict completion dates for practically all of the many projects to be engineered.

Challenge. The establishment and maintenance of an effective engineering design schedule in a large refinery is a task that merits the cooperation and understanding of all concerned. There are many factors working against adherence to predicted completion dates. Despite the most sincere efforts there will be many cases where man-day requirements will exceed the original estimates. There is constant pressure from project engineers, operating people and from mangement to improve dates or to establish dates that past experience might indicate to be unreasonable. The unanticipated jobs and unexpected additions to projects will continue to contribute to the dynamics of the overall problem. As long as the schedule is used as a guide to determine the timing and extent of engineering contracting to outside consultants, schedules must be made as realistic and accurate as possible. Gross overestimation of man-day requirements or overallowance for the unexpected can easily result in overcontracting and consequent inefficient utilization of company personnel. Scheduling of design work is indeed an important and a challenging problem for refinery engineers.

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ACKNOWLEDGEMENT

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Know Your Asphalts–Part 3

Chemistry of Asphalt Groups

Chemical make-up of the three components affect the properties and performance of asphalt.

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HOW IS the behavior of asphalt, through the behavior of its groups, related to chemical make-up? In discussing chemical composition of asphalts, analyses should be made of the separate "groups." These should be separated into "close cuts" to eliminate side fractions or otherwise overlapping material.

Asphaltenes. Working with extracted asphaltenes it has been shown that they are:

1. Made up of condensed aromatic rings with few side chains. Structurally these condensed rings are not too dissimilar to those present in highly condensed coal tar aromatics. Those from asphaltic origin are still somewhat soluble in certain solvents while those from coal tar are not.

2. Have carbon:hydrogen ratios of from 10 to about 12.1 to 1. Hydrogen content is lower than for the resins. Sulfur in an asphalt is concentrated in this group and may be as high as 9 percent from an original asphalt having 6.3 percent total sulfur.

3. Sulfonatable with sulfuric acid forming products slightly soluble in water but less soluble than those from similar hard coal tar fractions. The Nastjukoff reaction gives resins indicating absence of olefins, naphthenes, paraffines, etc., but showing cyclics. Asphaltenes can be hydrogenated to form the resins found in asphalts.

4. Molecular weights range from 9000 to as high as 140,000. However, with closer fractionation lower values have been obtained, one investigator reporting 1500.

5. They may be dehydrogenated to form carbon high carbon-content carbenes or further to form the almost inert, insoluble carboids, such as are found in cracked asphalts.

Asphaltene analyses for several asphalts according to Thurston are shown in Table 1.

TABLE 1
Ultimate Analysis of Various Asphaltenes

	Mexican Asphalt		Gulf Coastal
	200 F M.P. Blown	Hard Vacuum	200 F M.P. Blown
Percent Carbon	81.3	79.7	83.99
Percent Hydrogen	7.91	7.83	8.26
C:H Ratio	10.4	10.2	10.2
Sulfur, Percent	7.79	8.25	1.70
Ash, Percent	0.24	0.34	1.25
Oxygen, Difference, Percent	2.75	3.88	4.80

Hydrocarbon series of asphaltenes generally average C_nH_{2n-84}.

The resins and asphaltenes can overlap considerably unless the fraction studied has been carefully separated and highly purified. The resins are fairly devoid of aliphatics and their structure is very similar to the asphaltenes, with sulfur and/or oxygen present in the bridge structure.

A closely fractionated Middle East asphalt resin analysis is shown in Table 2.

TABLE 2
Analysis of a Middle East Asphalt Resin

Molecular Weight	PERCENT		Carbon/Hydrogen Ratio	Sulfur	Oxygen (Difference)	Series
	Carbon	Hydrogen				
1,300	80.27	8.34	9.6	7.41	3.98	C_nH_{2n-66}

The resins may be hydrogenated to oily material resembling the lubricating oils and may be dehydrogenated to form asphaltene type material.

The oils are similar to lubricating oils with their analyses depending to some extent upon the percentage of sulfur, nitrogen, oxygen and crude origin. Molecular weights average approximately 450-600.

They are usually saturated in nature, although iodine numbers may run as high as 60 or 70. Although only slightly sulfonatable their cyclic constituents do undergo the Nastjukoff reaction. They are much more stable to oxidation than the resins or asphaltenes. They may be dehydrogenated forming resins.

An oily cut from a soft Mexican asphalt gave the following analysis: Carbon, 85.39 percent; hydrogen, 11.39 percent; sulfur, 4.04 percent; iodine number, 42.

Carbon: Hydrogen ratio varies from about 6.8 to over 8. The ring analyses method of Waterman are also useful to give a clearer picture of constitution of the oily fractions from asphalts. Useful, too, is the characterization number (U.O.P. Method) which ranges from about 10.4 for oils from cracked asphalts to about 12.05 for the more paraffinic Mid-Continent types.

Hydrocarbons in the oils are: normal and branched chain paraffins, 10 percent; monocycloparaffins (paraffinic side chains) about 11 percent; about equally divided percentages of tricycloparaffins and mononuclear aromatics (one aromatic ring with one, two or three cycloparaffinic rings—condensed—together with their paraffinic side chains. The remainder of the hydrocarbons consist of di- and tri-nuclear aromatics and mixed aromatic-cycloparaffins. O'Donnell reports considerable sulfur in the aromatic-monocyclic and dicyclic fractions.

The oils belong mostly to the C_nH_{2n-6} to C_nH_{2n-18} series. Others have viewed the differences between the oils, resins and asphaltenes as nothing more than a difference in their C/H ratio.

Significance of Group Chemistry. More intensive studies are needed to form a conclusive insight concerning the nature of the above groups. It now appears more evident than in the past that these researches will be most profitable, as they have been in the various research projects on lubricating oils.

Already we know that the mutual solubility of these groups or their better degree of dispersion in one another is greatly affected by temperature changes.

The chemical constitution of the oils and resins probably affect group solubility and behavior of asphalts to a very much greater degree than do the asphaltenes.

Part 4 will appear in an early issue.

FIGURE 1—Basic tube cleaning equipment for water tube boilers, including (left to right) expanding wire brush on flexible shaft attached to motor, cutterhead and drill head.

FIGURE 2—Various drill-type cutter bits are useful for cleaning heat exchanger tubes. The bit drills its way through the tube, removing scale as it goes.

Good Tube Maintenance Tools Cut Costs

Here are the tools especially designed for boiler and heat exchanger tube maintenance that makes cleaning and repair easy and cuts downtime for repair.

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OVER-ALL PLANT operating costs can rise or fall depending on the condition of basic capital plant equipment such as boilers, heat exchangers, transfer lines, or air conditioning equipment. One of the large costs, downtime for repair, can be kept at a minimum if tubes are kept clean. A well planned preventive maintenance schedule will assure that the tubes are in good operating condition. And when repairs do become necessary, the right tools will make the job quick and effective.

The basic operations of maintenance and repair on tubular equipment are cleaning and retubing. The equipment necessary for these jobs consists of the tools that do the actual work and the units necessary for powering, holding, and maneuvering them. In addition, there are instruments for measuring and other specialized equipment. This article is concerned with describing equipment generally used for maintenance and repair and providing instructions for its use.

Tube Cleaning Equipment. Mechanical tube cleaners are the only type of cleaners that will do most of the all-around cleaning jobs in a plant. Recent advances in the designs of these cleaners now make it possible to clean tubes with sharp hairpin bends, curved tubes, and tubes of every size in all types of equipment. In addition, the tools can be operated by plant personnel at any time, with no elaborate preparations or chemical analyses. Selecting the right mechanical cleaning equipment for a job requires a

FIGURE 3—Air power is the fastest and most efficient method for cleaning. Illustrated is a drill-type cleaner used on heat exchangers. The hollow drill shaft conveys air or water to the bit to keep it cool and wash chips away.

knowledge of only a few factors: the type of tubes that require cleaning, the types of deposits present, and the type of power available.

All tube cleaners operate on essentially the same principle: "turbining" or "punching" the tubes with air, water, or steam motors or electrically-driven flexible-shaft units. A revolving cutter, brush, or other accessory attached to the cleaner is driven through the tube to dislodge scale and other deposits. Choice of an accessory for a particular job depends on the type and hardness of the deposit and the construction of the tubes.

Least expensive of the accessories is the expanding wire brush (Figure 1), an item confined to cleaning where the deposit is neither hard nor gummy. This type of brush does a satisfactory cleaning job, even when the tubes have numerous curves and sharp bends. In the expanding brush, the wires are arranged in tufts or clusters to form what is known as a cartridge. Each cartridge is so mounted that the brush element has some radial play. When the brush revolves, centrifugal action forces the wire tufts against the deposit. It is a simple matter to replace the cartridge when the wires become worn. This type of brush is the most widely used tool for cleaning boiler tubes.

Expanding scrapers are similar to expanding brushes, but instead of wire brush refills, hardened-steel scrapers are fixed to the sides of the holder. Scrapers are useful for removing soft, some gummy and wet deposits that would ordinarily clog the bristles of a brush. They are most suitable for cleaning fly ash and soot from fire-tube boilers.

A drill type cutter bit (Figure 2) is especially useful for cleaning heat exchanger tubes. The bit drills its way through the tube, removing scale as it goes. These bits, capable of sustained operation at temperatures up to 700 F., are generally designed with 2 or 3 flutes and have a cutting angle of approximately 120 degrees. Some cutting edges are rather stubby and ground with reverse rake angles. Occasionally, for some plugged tubes, auger-type bits are used when the deposit is spongy. The cutter bit has a hollow center and exhaust holes through which a scavenger material flows. The scavenger, usually water or air, softens fouled matter, washes away debris, and keeps the bit cool.

Cutterheads are used in straight or curved tubes to remove hard and thick deposits. A cutterhead contains cutter wheels that have sharp revolving cutters that chip and pulverize the scale. Selection of a cutterhead depends on the type of deposit to be removed. When very thick scale exists, a cutterhead with a very limited cutting area usually does the best job of roughing out in a short time. When the scale is not too hard, a cutterhead with a greater cutting area is best.

Sometimes tubes that have not been cleaned in a long time develop so much hard scale that a cutterhead will not enter the tubes. Here, a drill-head mounted on a universal joint must be used. The drill is somewhat similar in action to a cutterhead, but it will enter smaller openings. It is only used as a first pass through the tube to eliminate the worst part of the scale. A cutterhead, used for a second pass, leaves a smooth, clean surface.

Available power at the installation mainly determines the type of power for driving the accessory. However, there are other considerations. Air power is the fastest and most efficient for cleaning tubes. The deposit is loosened and then blown out of the tube by the exhaust air of the motor. Recommended pressure is 80 to 100 pounds per square inch, although cleaning is sometimes accomplished with pressure as low as 50 psi. Water-driven cleaners, while not as powerful as those driven by air pressure, are quieter. And the water flushes the tube simultaneously while cleaning (Figure 3). Operating pressure varies from 125 to 250 psi., the smaller sizes of the tube-cleaning units requiring more pressure than the larger sizes. The higher the pressure, the larger the volume of water necessary. It is important that drainage facilities be available to drain off this water at approximately the same rate as it is fed by the equipment. Water-driven cleaners are not recommended for the majority of fire-tube boilers.

Steam-powered units are substantially the same as air-driven units and require the same pressure. There is less leeway in pressure ratings however. At pressures below 80 psi, there may be excessive condensation, and

FIGURE 4—If a leak developes within the first few inches of a condenser or heat exchanger tube, an insert will seal off the deteriorated portion and restore the tube to service. In addition to eliminating replacement of a bad tube, the insert also retards the effect of inlet-end erosion.

above 100 psi, the increased temperature may make the operation hazardous. Live steam, always a potential hazard, requires great care in its use.

All these driving mediums have their advantages as well as disadvantages, and the choice very often depends on individual taste. For example, air cleaners are the most popular. Fast and powerful, they are also noisy and stir up dust. Water cleaners hold down dust, but are slower and require rapid drainage facilities. Steam cleaners sometimes have a desirable softening effect on some types of deposits, but live steam is always a potential hazard. Electric cleaners are quiet and sometimes are the only cleaners that can be used. If all these sources of power are available, choice of method depends on plant conditions and operating requirements.

One type of specialized tool for the periodic cleaning of condensers is a gun that uses water or air to force a plug or brush through the tube, forcing the soft deposit ahead and out of the tube. Recommended pressure is over 65 psi. Other tools are available for special cases.

Here is an example of how a plant used these tools and methods to cut labor costs substantially. Two years ago, this plant had to close down a continuous process for three days, four times a year, to clean its vertical heat exchanger tubes. The shutdown caused a loss of production estimated at 4 percent. Each heat exchanger had 554 2-inch 10-gage copper tubes, 18 feet long. Some of the tubes were solidly plugged with a very hard deposit. Cleaning methods required nine eight-hour shifts using three men, a total of 27 man-days.

The plant switched to an air-driven cleaner with accessories that included cutter bits. The new equipment cut cleaning time by 50 percent, increased production 2 percent, and saved 54 man-days labor annually. The savings in labor costs in six months more than paid for the cleaning equipment. In addition, the equipment is used in the plant for other cleaning problems.

Retubing Equipment. Proper tools make it an easy, inexpensive matter to repair or replace tubes that have failed in service. If a condenser or heat exchanger tube develops a leak within the first few inches of the inlet, it is not necessary to replace the tube. Inserts are available to seal off the deteriorated portion of the tube and restore it to service (Figure 4). The insert also retards or eliminates the effect of inlet-end erosion. Instead of operating at partial efficiency with plugged-off tubes, the unit will continue at full efficiency. The inserts, five inches long, have a pliable acid-resistant synthetic rubber coating firmly bonded to a metal tube composed from an alloy that suits the particular conditions. The inserts come in outside diameters of ⅝ to 1¼ inches.

Sometimes it is necessary to replace the tubes. Modern tube replacement requires more than the expander, chisel, and set of hand tools used to retube fire-tube boilers years ago. The first step in retubing condensers or other heat exchangers is removal of the head. It is often necessary to brush the face of the tube sheet clear of scale or other matters that might impede tube removal. Heavy duty brushes and adapters driven by an air-driven drill are available to do this job.

Tube removal is next. There are two basic types of tube-removal tools: (1) The internal tube cutter, used only for cutting tubes just back of the tube sheet to free it from the tube bundle and (2) The wall reducing tool, a special piloted type of drill that relieves pressure at the joint by removing most of the tube wall. The internal tube cutter is used only when the tube bundle is not secured in the shell as in units where the tube sheets are welded to the shell. In such units, the wall reducing tool will relieve the pressure at the tube joints, allowing the tubes to be removed through their own holes. A tube knockout tube with the same dimensions as the wall reducing tool will drive the tube ahead about 6 inches and allow it to be pulled from its hole. When a tube cutter is used, the tube ends remaining in the tube sheet are removed in a similar manner.

If the old tube sheets are to go into the retubed unit, it is desirable to clean all tube holes thoroughly to free them from rust, scale, and oil. Expanding brushes, described in the section on tube cleaning, are ideal for this function. If new tube sheets are used, standard drills are satisfactory for making the holes. But reaming these tube holes from 0.005 to 0.010

About the Author

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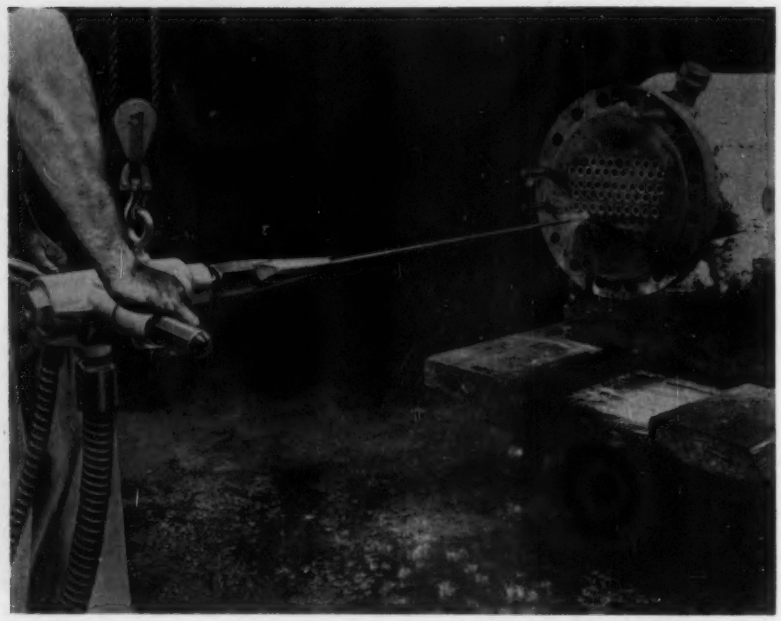

FIGURE 5—Expansion control is very important in tube expanding. Under-rolling causes too loose a joint, while over over-rolling may cause the join to fail in service. The pictured tool measures torque directly at the mandrel and stops rotation of the expander when the pre-set torque is reached. It is simply adjusted through a dial calibrated in foot-pounds of torque.

inch over the tube diameter requires reamers of special sizes, not available as standard machine tools. A grooving tool is used to cut helical anchoring grooves into the tube hole after it is reamed. The tool operates like a tap with a pilot, but is only run approximately ¾ inch through the tube sheet thickness.

After the tubes have been cut to the exact length, allowing for approximately a 1/16-inch projection beyond each tube sheet, it may be desirable to round off the tube ends. A simple tube-end radius facing tool will produce a fine radius in the inner and outer end of each tube. The tool can be used in any portable drill, and a quick application at the tube end completes the operation.

Next it is necessary to feed each tube through the tube sheet hole and the supporting baffles and guide it out of the hole in the far tube sheet. A very simple pilot or guide, inserted into the tube end before it goes into the unit, will protect the finely finished tube end and facilitate passage through the unit.

The next operation is tube rolling or expanding. Tube expanding is basically the cold working of the tube end to form a tight frictional joint. The job is done with an expander, a tool that fits into the end of the tube and enlarges it to make the outside of the tube fit flush against the tube-sheet hole. The most common type of expander consists of three rolls mounted in a cylindrical cage or body through three longitudinal slots. The slots hold the rolls loosely, allowing them to move outward or inward. A free-moving pin or tapered mandrel fits through the center of the cage and bears against the rolls. When the expander is inserted into the tube end, the rotating tapered mandrel forces the rolls outward, and the rolls and the mandrel both start turning. The automatic forward travel of the mandrel combined with the rotating action rolls the tube slowly and smoothly. Ironing out and enlarging the tube, the expander finally enlarges the tube to make it fit tightly against its mating part, commonly known as the tube seat.

Expanding is a precise operation. The tube joint should be neither over nor under-rolled and yet be able to withstand designed operating pressures. Under-rolling causes a loose joint while over-rolling may cause the joint to work-harden and ultimately fail in service. There are several methods available to control the degree of expansion: manual feel of the resistance to torque through the expander mandrel; and electronic, frictional, magnetic and mechanical torque controls either powered by air or electric motors. One recently developed control is an air powered, single unit mechanical device (Figure 5) which measures torque directly at the mandrel and automatically stops the rotation of the expander at a preselected torque setting. The torque setting may be simply adjusted by regulating a dial calibrated in foot-pounds torque. This type of control assures uniformity of expansion regardless of tube-hole or tube-wall variation. This uniformity of tightness that has been the goal of engineers ever since tube expanding has been practiced.

After the tubes have been expanded, it may be necessary or desirable to machine off all or part of the tube end projecting from the tube sheet. Tools for this job are a flat-type end facing tool, which shortens the tube by making a square edge, and a radius facing tool, which both shortens the tube end and provides a slight radius on both the inside and outside edge of the tube.

Where flow turbulence is a problem, the tube ends are often belled out or flared. This operation is done on the projecting end of the tube outside of the tube sheet or in part of the tube sheet-hole that has been chamfered with a radius cutting tool. Flaring can be done in one step with a flaring tool alone, or it may be followed with a beading tool for a beaded finish. The flaring tool is tapered to flare the tube by a blow from a mallet or air gun. The belling or beading tool works similarly, but pushes the projecting flared ends completely back to the tube sheet.

At the end of the necessary expanding and finishing opertions, a pressure test will assure fitness. When a tube shows leakage, rerolling will be necessary. However, the amount of expansion should be kept to a minimum to prevent over-rolling. ##

Contact Efficiency Influences Design

An analytical comparison is drawn between the contact efficiency of fluidized and moving bed processes.

Part VIII reviews some typical fluid bed reactor designs for petroleum cracking, hydrocarbon synthesis, and nuclear power generation. Part VII, "How to Predict Gravity Flow Rates," which appeared in the October REFINER reviewed the major published studies and offered equations and charts for predicting gravity flow rates.

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DESPITE THE MANY years that fluid catalytic cracking units and various other commercial fluidized solid processes have been operating successfully, the fundamental aspects of the mechanism of gas flow within the bed have yet to be fully resolved. Small scale experimental studies of the effects of particle and fluid characteristics on overall bed density, mass transfer, heat transfer, and solids entrainment have been reported in numerous publications. In all these studies, the discrepancies between the data of various investigators and the discrepancies between commercial unit results and small scale tests, require an understanding of the transfer mechanisms, and this in turn requires a quantitative appreciation of the physical characteristics of flow within the bed mass.

Heat Transfer. Consider for example the problem of heat transfer from or to a fluidized bed of solids. The small scale experiments reported in the literature involve in most instances over-all measurements for beds ranging from one foot to three or more feet in height contained within 1-inch to 4-inch diameter tubes. Anyone concerned with fluid bed operations has at some time or other witnessed fluidization of various particles in such small tubes and realizes immediately that in a small diameter it takes only a relatively short bed height before a piston-like slugging phenomenon sets in (see Parts 1 and 2 of this series).

This immediately indicates that over-all heat transfer measurements in small tubes of high height to diameter ratio are only the effective results of a combination of transfer mechanisms involving a fluid bed of the usual concept, a moving slug of solids of fixed bed density, and a region of gas through which the slugs shower down in a high degree of dispersion. Within a commercial unit, boiler tubes see similar regions of high and low solid concentrations, but the ratio is frequently quite different than occurred in experimental apparatus. Thus an over-all coefficient for a commercial unit can only be properly predicted by an analysis of the probable distribution of such regions within the commercial bed and the heat transfer coefficients corresponding to both conditions.

Catalyst Entrainment. An even greater source of controversy may be found among the studies of catalyst carry-over from small fluidized beds. Even within the observations of a single investigator there appear to be incompatible results. For example, in the work of Hyman[9] it was reported that at 1.9 ft./sec. superficial air velocity the entrainment rate (expressed as lbs./sec. x sq. ft. of column cross section) of 60 to 80 micron glass spheres from a 2-inch diameter column was about twofold the rate from a 3-inch column. If the solids were a ground silica-gel catalyst of the same average particle size the effect of column diameter was reversed and the entrainment rate from a 3-inch column was about threefold that from a 2-inch column.

Hyman worked with 1¼, 2, and 3-inch tubes fluidizing glass beads and ground silica catalyst. He was not able to obtain a generalized correlation including the effect of column diameter. He did conclude, however, that "the factor of major importance with respect to the rate of entrainment is the nature of the bubbling charactertistics of the dense bed."

Carry-over from small diameter, high L/D, experimental units, in which the gas bubbles within the fluidized mass reach tube diameter proportions giving rise to slugging, can only by coincidence ever be expected to correlate with the entrainment from large diameter commercial units (see Part 3 in this series) where the emerging bubbles may reach several feet in diameter but never the diameter of the entire vessel.

Within the observations of "the nature of the bubbling characteristics of the dense bed" lies the only fundamental correlant of "quality" of fluidization, elutriation, heat and mass transfer, and solids turnover, etc. The question of what type of grind makes a well fluidizable bed (see Part 2 of this series), and the effect of addition of fines in decreasing or increasing carry-over must be correlated to the bubbling characteristics of the bed as well as the transport capacity and disengaging height.

In comparing small scale entrainment observations with commercial data, it must also be remembered that in a producing unit entrainment is most frequently reported as solids content of the effluent leaving the cyclones. Even in instances where cyclone performance may be fairly well defined, it is not surprising to find entrainment figures in excess of what would be predicted even before the cyclones. Such results may be due to insufficient dipleg height or diameter (see Part 7 of this series),

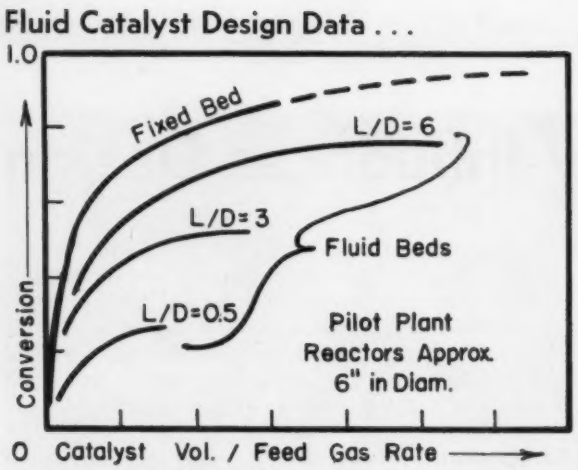

FIGURE 1—Schematically illustrates the effects of fluid bed operations at various bed height-to-diameter ratios in comparison to fixed bed results.

perhaps coincident with excessive cyclone pressure drops, or else the establishment of a slugging bed condition within the dipleg of a last stage cyclone handling a negligible downflow of solids.

Mass Transfer. In a fluid bed of fine particles, there are two distinct ranges of gas holdup time, most gas passes through the bed in the form of bubbles at a velocity several times the superficial velocity (and accordingly at low holdup times) while a small portion of the gas finds its way through the dense phase, where it remains for a relatively long time. The quantity of gas having a long holdup time in the dense phase is a relatively fixed amount, and so the proportion of the total throughput having a short holdup time increases with superficial velocity.

Bubblephase gas (with short holdup time) is exposed to quite different reaction conditions than dense phase gas (with long holdup time); the degree of conversion or contact is markedly different and the over-all product distribution a function of the relative quantities of the two kinds of gas flows and the degree of contact experienced by each. Reactor geometry, particle size, and superficial velocity will alter the relative flows, and therefore the over-all conversion or contact, considerably.

In general, the larger the bubbles which emerge from the top of a fluid bed, the lower the conversion. The exchange of gas between a bubble and the surrounding denser phases can be expected to be less the larger the bubble, and therefore the degree of unconversion in the emerging bubble will be greater.

In an 8-inch reactor from which bubbles with a diameter of 4 inches are emerging, there can be a sizeable quantity of unconverted feed gas in the bubbles, even though the surrounding gas which has percolated up through the interstices of the dense phase may contain practically no unconverted feed. However, if a bubble grows very nearly to the diameter of the reactor, there is no longer a mechanism for establishing a concentration gradient between gas within a bubble and gas in the denser phase.

It is not necessarily suggested that it is always good practice to operate in the slugging regime but it is to be noted that some small diameter laboratory units with a high ratio of length to diameter, which give good conversion, usually do operate in the slugging condition. Different conversions may be achieved with slugging according to the location within the reactor at which gas slugs first appear.

At a given space velocity, higher conversion will be obtained in a deep fluid bed than in a shallow one. The effect of increased bed height may well be to change the fluidization regime from one in which bubbles of moderate size give low conversion, to one in which incipient gas slugs give high conversion by making gas composition uniform and dispersing solids in gas rather than gas in solids.

If, at a fixed space velocity, the catalyst bed height is increased, there is a greater tendency for gas slugs to form, because of the higher gas velocity and the longer path for bubble growth. This view explains the improved performance of laboratory reactors at higher bed height.

Figure 1 illustrates schematically the effects of fluid bed operations at various bed height-to-diameter ratios in comparison to fixed bed results. Mathis and Watson[15] have published quantitative data on studies of the dealkylation of cumene in 2, 3 and 4-inch reactors which illustrate the trends of Figure 1 remarkably well. One could not expect comparable improvements in commercial size reactors of large cross-section, where formation of gas slugs is out of the question.

Dispersion of Gas. There seem to be two modes of obtaining good gas-catalyst contact in the fluid state: 1. To insure uniform dispersion of small gas bubbles in the dense phase solids, 2. To disperse solids in dilute phase in the gas stream. In No. 1, dense phase solids constitute the continuous phase. Numerous investigators have appreciated these problems and it is of interest to note the directions design patents have taken in regard to both means of improving contact.

Dispersion of gas in dense phase solids can be accomplished by breaking large bubbles into smaller ones using baffles, packing, or agitation, or else by redistributing the gas, which effectively breaks a deep bed into a series of shallow beds (see box for partial list of patents).

A partial list of patents devised to disperse gas:

1. Sensel and Beck, U. S. 2,562,993 suggested use of a stirred reactor provided with a helical rotating screw running the length of the reactor.
2. Matheson, U. S. 2,533,026 suggested filling the reactor with Raschig rings or Berl saddle packing to provide a tortuous path for the gas.
3. Hogan and Banks, U. S. 2,606,104 suggested conical perforated plate baffles spaced at various intervals to break up gas bubbles and distribute solids.
4. Matheson, U. S. 2,557,685 suggested placing short tubes in a spiral pattern throughout the reactor so that when a bubble of gas reached the bottom end of such a tube solids would be discharged into the bubble.
5. Watson, U. S. 2,463,729 and Wilcox, U. S. 2,520,983 suggested perforated plate tray type reactors.
6. Huff, U. S. 2,607,662 and Ford, U. S. 2,582,688 suggested a bubble cap tray type reactor which in essence breaks a deep fluid bed into a series of shallow fluid beds.

Most of these suggestions are applicable only under special conditions and are impractical for large scale commercial units. For example, the use of a stirring device gives excellent results in small diameter units but would not be practical in a large vessel (say 10 to 20 feet in diameter).

The use of packing material is strictly applicable only

TABLE 1—Mechanics of Gas-Solids Contacting

GAS DISPERSION	SOLIDS DISPERSION		SOLIDS CIRCULATION
Bubbles	**Slugging**	**Transport**	
Form: Baffled reactors to break bubbles.[5] Theory: It was reasoned that gas bubbles would be broken up into smaller bubbles as they went through the baffles, and that solids would be pushed up through the baffles ahead of the gas and also flow down through the baffles when a bubble was not present. **Evidence:** Experiments have shown that bubbles merely elongate and are not really broken up. Bubbles can grow to 12" in diameter in 4'–5' of bed (see Part I of this series) and rise at velocities up to 10 feet per second. Overheating due to retardation of solids mixing is a particular problem. In deep commercial size beds erosion would also make baffles unattractive.	**Form:** Small diameter (high L/D)[6] fluid reactors. **Theory:** Good catalyst-gas contact due to disperse phase contact when catalyst slug rains down through gas between slugs. Note that in this arrangment gas sees all of the solids and sees it all in the disperse phase. **Evidence:** Highest conversions and best results obtained in small diameter reactors.[15]	**Form:** Up Transport Tube (disperse phase) **Theory:** Good catalyst-gas contact due to high degree of dispersion of solids in gas such as is obtained when solid slugs "rain" into gas. Note however that it may be difficult to get sufficient solids loading to convey heat of reaction in an endothermic reaction; it may also be difficult to ensure the gas "seeing" enough of the solids present (as compared to the slugging fluid bed where gas sees all of the solids in the disperse phase). There is also present the problem of possible erosion difficulties. **Evidence:** So-called "empty" reactor pilot plant data in which high conversions were obtained when reactor contained so small an inventory of catalyst that voidages were in the neighborhood of 95% or more and only disperse phase was present.[11] Humble Oil and Refining Co. has recently reported putting a "transfer line reactor" into commercial operation.[7] Dilute phase transport reaction schemes for conducting hydrocarbon synthesis from Hydrogen and CO[10] and various other processes have been patented.	**Form:** Vertical Screw Conveyor within the fluidized bed.[16] **Theory:** Mechanical pumping of solids should provide high solids circulation rate permitting excellent temperature control in fluid beds. The gas passing countercurrent to the solids flowing down outside of the conveyor tube should come in better contact due to this circulation (it is proposed that in this contacting portion of the bed, some form of obstruction such as Raschig rings or studded coolant tubes would aid contact also). The added advantage of such a mechanical circulation device lies in its permitting independent separation of the problems of contact and circulation, whereas in the disperse phase transport tubes contact and circulation are intimately inter-related. **Evidence:** No experimental investigations reported.
Form: Stirred Reactors.[16] **Theory:** Should give better catalyst-gas contact due to mechanical carrying of solids into gaseous regions within bubbles. **Evidence:** Stirred pilot plant reactors give results as good as those obtained in simple 2" tube reactors. Though the data are not conclusive since the stirred reactors tested were only experimental scale, it is still to be expected that even larger stirred reactors would give better contact than simple vessels with no provisions for inducing additional contact. Obviously, the power requirements and mechanical problems make such schemes unattractive on a large scale.			**Form:** Screw Conveyor operating as upcomer with reactor feed gas flowing co-currently downward in the reactor proper. (A fluidized upcomer has also been suggested.[13]) **Theory:** Solids would be conveyed from bottom to top of bed by means of a screw conveyor located in the center of the bed. The solids would then overflow at the top of the conveyor and pass downwardly to the bottom of the bed. Feed Gases would enter at the top of the reactor and pass downward cocurrently with the solids. Presumably such a reactor would give good contact since no bubbles are formed; in addition, entrainment losses are eliminated. This is in essence a moving fixed-bed reactor. The disadvantages lie in high pressure drop and the elimination of dead areas of non-circulating solids as well as the added expense of the mechanical screw conveyor. **Evidence:** This scheme as well as the one above has apparently never been investigated on a pilot plant scale. The mechanical aspects are not commercially attractive.
Form: Raschig Ring Packed Towers.[14] **Theory:** It is reasoned that the gas will travel a more tortuous path and thus see more solids; also that bubbles will be broken up hitting a piece of packing and solids will be showered into it. There appears to be a dispute as to whether or not the packing will impede solids flow and also as to whether solids will hang up on the packing and channeling occur both on the gas and the solids side. **Evidence:** Visual studies of fluidization of fine powders in packed beds of Raschig rings and spheres as well as gravity flow studies indicate considerable channeling of the gas flow and the existence of dead pockets of solids.	**Form:** Up-Transport Tube operating under condition of slug flow. **Theory:** In an effort to reduce the erosion objections to the disperse-phase Transport Tube and simultaneously increase the solids loading to carry away heat of reaction, it was proposed to operate an up-transport tube at so low a gas velocity that the solids would be transported as slugs. It is also assumed that as the solids travel upwards in slugs they will rain down as did the slugging, high L/D, fluid beds and thus disperse phase contact will still be achieved. **Evidence:** Observations that in transport the slugs *do not* shower. If the slugs do not shower, then of course in any slug-flow tube the catalyst-gas contact would be very poor.		

to solids exhibiting so-called "free flowing" characteristics and therefore any possibility of wax, coke, or other deposition in a commercial unit would lead to channeling and maldistribution of gas and solids.

The use of perforated plate baffles was tested in pilot plant units and found to retard top to bottom mixing of solids to such an extent that hot spots were developed and bed temperature gradients of over 100 degrees were obtained rapidly.

It would appear that the only feasible solution to the problem of breaking up large bubbles lies in redistribution of the gas by effectively breaking up the bed into a series of shallow beds and in the use of small size particles permitting higher length to diameter beds before bubbles grow to excessive size. Obviously grid plates in each instance must be designed for sufficient pressure drop to insure good initial distribution of gas entering the bed.

Dispersion of Solids. Dispersion of solids within the continuous fluid medium can be accomplished by:

1. Operation with a low inventory of solids at a sufficiently high gas velocity to obtain essentially disperse phase fluidization,

2. Use of small diameter reactors of high length to diameter ratio in which slugging forces solids to rain down through the gas pockets or,

3. Operation of the reactor as a transfer line in which reaction takes place as fluid and solid flow in a dilute suspension. (See box for list of patents and references on solids dispersion.)

A partial list of references to suggested means of obtaining such contact by dispersion of solids.

1. Hujsak, Kratzer, and Mungen, U. S. 2,620,262 and Barr and Rex, U. S. 2,626,234 have suggested compartmentalized reactors which would lead to high length to diameter ratio slugging type units in parallel.
2. Latta, U. S. 2,548,801 has reported results using a reactor with merely an inside coating of catalyst. Perry and Merrill, U. S. 2,607,553 suggest use of catalytically active metal gauze.
3. Kirkbride and Dart, U. S. 2,628,188 suggest use of the lift leg of a T.C.C. unit as a transport reactor.
4. Jewell and Johnson, U. S. 2,543,974 have patented a dilute phase transport type reactor for Fischer Tropsch synthesis.
5. Goodson and Guyer, U. S. 2,606,097 suggest an up and down flow dilute phase transport reactor.
6. Humble Oil has reported on the conversion of the Baytown unit to a transfer line reactor (see Petroleum Refiner 32, No. 2, 135-7, 1953).
7. Various other dilute phase schemes are suggested in U. S. patents 2,465,255; 2,489,863 and 2,498,088.

The use of a multiplicity of small tubes or a compart-

mentalized slugging type reactor for commercial scale operations would present no scale-up problems. However, the cost of the reactor itself plus the cost of providing good vapor distribution to each compartment or tube, makes the entire installation relatively expensive and somewhat less attractive than a transfer line type of unit. In operation either will give performance equal to or better than obtained from a series of shallow fluid beds, if properly designed.

Keep in mind that the entire preceding discussion is intended to apply to reactions in which gas-catalyst contact is of prime importance and high conversions are desired. There are numerous process applications of the fluid bed technique in which temperature conditions alone, or moderate conversions, etc. are sufficient for commercial application; catalytic cracking of hydrocarbons is of course an outstanding example. On the other hand, the Fischer-Tropsch synthesis requires a reactor designed to give intimate gas-solids contact.

A number of investigators have explored gas-catalyst contact in fluid beds by experimentally studying specific reactions and expressing the results in terms of a mass transfer coefficient. An excellent review and correlation of these detailed academic investigations into the mechanisms of the mass transfer is given in the work of Chu.[3]

Table 1 presents an attempt to classify under broad categories the general qualitative pilot plant and commercial scale observations and ideas bearing on mass transfer aspects, or more simply particle-fluid contact, in catalyst-gas systems. Note that in the various bubble forming reactors there is a consistent string of evidence that large bubble formation is highly undesirable. Note also that in all fluid bed type catalytic cracking units feed gases and catalyst are always contacted in dilute phase at some point in the system such as inter-vessel transfer lines. For example, regenerated catalyst is carried in "pneumatic" transport into the reactor by means of vaporized feed gases.

No published data are available for evaluating to what extent the success of fluid catalytic cracking operations can be attributed to the degree of reaction taking place in such dilute phase contact. Certainly some trends in cracker design[9] indicate that good contacting and a high degree of reaction have been obtained in experimental units. If this be the case it is small wonder that difficulties have been met in attempting to evaluate the loss in contact through by-passing of gas inside the bubbles in commercial scale fluid bed units. The transfer line contact may well overshadow a portion of such inefficiencies. It is significant to note that thinking in synthesis reactor design[10] has also involved dilute phase contacting in transport.

Effectiveness of Contact in Catalyst-Gas Systems. In attempts to obtain a better insight into the mechanism of mass transfer, several studies of gas and solids mixing in fluidized beds have been reported in the literature. In these studies it has been fairly well recognized that all the gas fed to a fluid bed in excess of that required to initiate fluidity passes upwards in the form of bubbles. Both visual studies as well as bed density determinations have shown that bubbles rise through the bed at velocities of the order of 10 to 1000 times the minimum or incipient superficial fluidization velocity. Bubble velocities in the range of 1 to 10 feet per second have been measured by photographic techniques.

If all the gas passing through a bed as bubbles were to be considered as bypassing any contact with the catalyst we would predict that only a negligible degree of reaction could be obtained in fluid reactors. Obviously the success of commercial operation indicates other mechanisms at play. Studies of such other possible contact mechanisms have revolved about diffusion of gases from bubbles to interstices, mixing due to shifting of large bed masses, raining of solids into the bubbles etc. None of these results have shown any great promise of enlightenment in the field of fluidization nor any pointed direction for future development. A more naive approach based on a simple model of bubble flow through a fluidized bed and the available particle surface area gives a remarkably good qualitative appraisal of comparative results to be anticipated from gas fluidized operations.

Simplified Model of Gas Flow in Aggregative Fluidization. Consider a fluidized bed one square foot in cross section, L feet high, being fed a volume of v cubic feet of vapor over a unit period of time. The minimum vapor volume required to fluidize the bed is calculated to be v_{mf} cubic feet. Gas passing up through the bed within the interstices is then v_{mf} and that passing up as bubbles is $(v - v_{mf})$.

Let N equal the number of bubbles of average size D_B having risen through the bed at an average velocity of rise V_B feet per unit time. The volume of gas in one bubble is then:

$$\frac{v - v_{mf}}{N} = \frac{\pi D_B^3}{6} \qquad (1)$$

The time interval of residence of a bubble within the bed is given by L/V_B. Assume that all the bubbles formed from $(v - v_{mf})$ quantity of gas remained stationary within the bed for a time L/V_B and that during this time gas flowed from the bed interstices below the bubble at a velocity of v_{mf} into and out of the bubble. The lower surface area of the bubble (assuming a spherical shape) is:

$$\frac{\pi}{2}\left[\frac{6(v - v_{mf})}{\pi N}\right]^{2/3}$$

The volume of gas purged out of one bubble during its time interval of residence in the bed is then

$$\frac{\pi}{2}\left[\frac{6(v - v_{mf})}{\pi N}\right]^{2/3} \frac{L v_{mf}}{V_B}$$

The fraction of bubble gas unpurged is therefore

$$\frac{(v - v_{mf})}{N} - \frac{\pi}{2}\left[\frac{6(v - v_{mf})}{\pi N}\right]^{2/3} \frac{L v_{mf}}{V_B} \Big/ \frac{(v - v_{mf})}{N} \qquad (2)$$

In terms of the entire quantity of gas fed to the unit

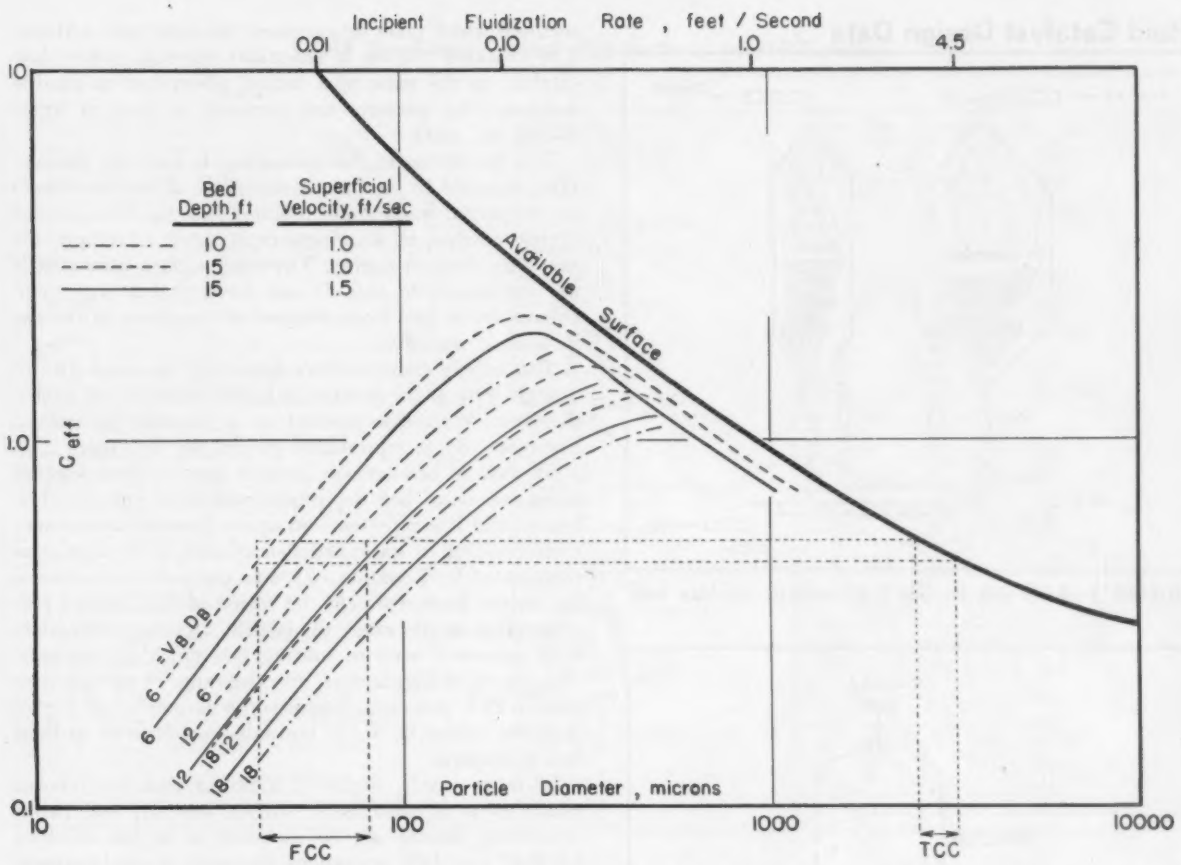

FIGURE 2—Relative effectiveness of contact in catalyst-gas systems. This graphically represents Equation (8) as a function of bed depth and superficial velocity. The heavy solid line represents an upper limit of surface area corresponding to static bed density and no by-passing as represented by Equation (7). For comparative purposes, the dotted lines represent the region of C_{eff} factors corresponding to the range of particle sizes (approximately 3000 microns) used in moving bed cracking processes.

the fraction of unpurged or bypass gas is then $(v - v_{mf})/v$ times Equation (2) which simplifies to:

$$\left(1-\frac{v_{mf}}{v}\right)\left(1-\frac{\pi^{1/3}\,6^{2/3}\,LN^{1/3}}{2V_B}\,\frac{v_{mf}}{(v-v_{mf})^{1/3}}\right) \qquad (3)$$

From Equation (1):

$$N^{1/3}=\left(\frac{6}{\pi}\right)^{1/3}\frac{(v-v_{mf})^{1/3}}{D_B}$$

and substituting this in Equation (3) — Fraction of gas bypassing catalyst $= \left(1-\frac{v_{mf}}{v}\right)\left[1-\frac{3Lv_{mf}}{V_BD_B}\right]$

The fraction of gas contacting the solids is then

$$1-\left(1-\frac{v_{mf}}{v}\right)\left[1-\frac{3Lv_{mf}}{V_BD_B}\right] \qquad (4)$$

Carman[2] and Kozeny have shown that the surface of contact in the flow of fluids through beds of powders is related to the pressure gradient by the expression:

$$s^2=\frac{\Delta P g \varepsilon^3}{Lk\eta v} \qquad (5)$$

where: s = surface per cubic foot
ΔP = pressure drop
L = bed depth
g and k = constants
ε = voidage
η = fluid viscosity
v = velocity through bed

At incipient fluidization $\Delta\rho/L$ becomes the bed density and v is v_{mf} so that Equation (5) could be written.

$$s=\sqrt{\frac{\rho_{bed}K\varepsilon^3}{v_{mf}}} \qquad (6)$$

Permitting the assumption that $\rho_{bed}^{1/2}$ and $\varepsilon^{3/2}$ do not change appreciably with particle size we may write:

$$s \approx 1/\sqrt{v_{mf}} \qquad (7)$$

In the case of particles smaller than 300 microns, S can be taken proportional to the reciprocal of the particle diameter.

Contact Effectiveness Factor. The product of Equations (4) and (7), corrected for the lesser specific surface in an expanded bed, is termed the contact effectiveness factor and gives an indication of the relative surface contact which can be expected with changes in bed variables:

$$C_{eff.}=\left(\frac{L_o}{L}\sqrt{\frac{1}{v_{mf}}}\right)\left[\frac{3Lv_{mf}}{V_BD_B}\left(1-\frac{v_{mf}}{v}\right)+\frac{v_{mf}}{v}\right] \qquad (8)$$

where $C_{eff.}$ = contact effectiveness factor
L = fluidized bed height
L_o = static bed height

It is felt that the Carman Kozeny type of surface is more representative of the gas-catalyst contact area than the type of surface obtained by nitrogen adsorption

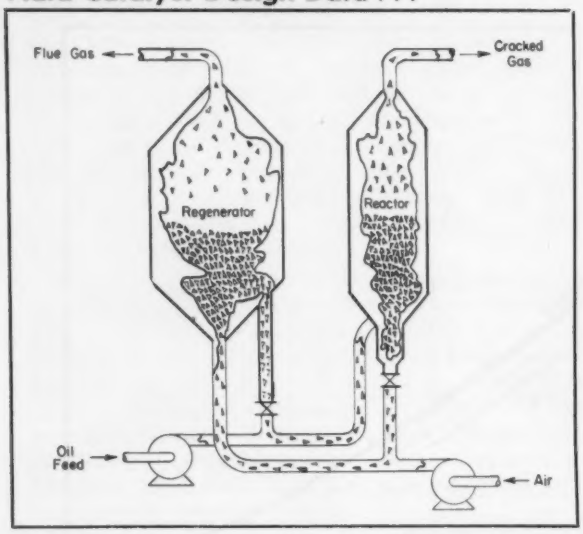

FIGURE 3—Early side by side fluid catalytic cracking unit.

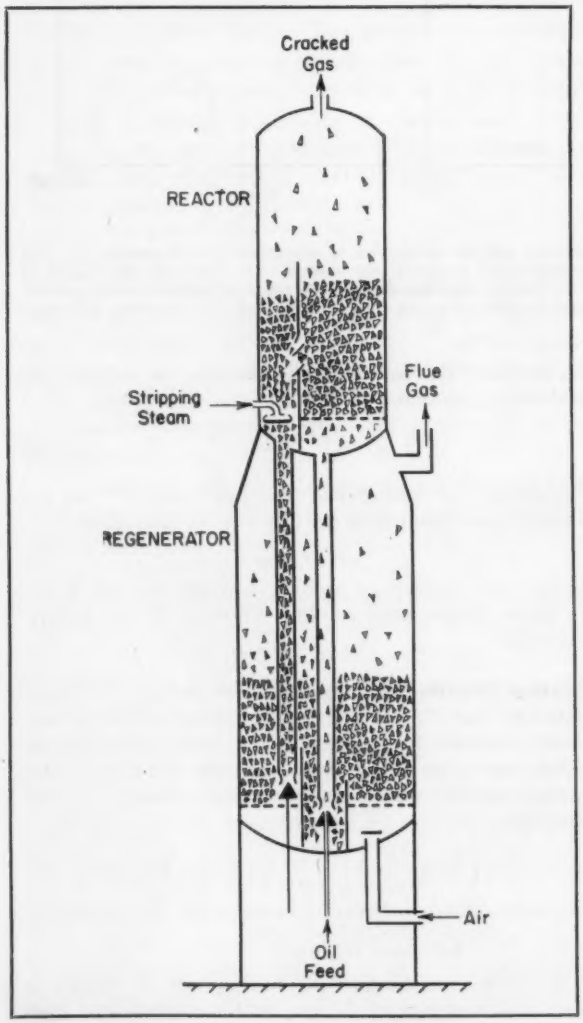

FIGURE 4—The Orthoflow fluid cracking unit.

methods which takes into account the inner pore surfaces. The cracking process is essentially thermal rather than catalytic in the sense of a radical adsorption on catalyst surfaces. The particles are primarily a form of introducing hot surface.

It is interesting in this connection to note the observations reported by Agron[1] on the effect of catalyst masses on the partial oxidation of propane with air. The purpose of the catalyst in this instance is solely to supply the necessary thermal energy. The total surface presented is not important; in fact, it was noted that a large pore volume led to low yields because of stagnation of the gas in laminar deposits.

The bubble characteristics appear in Equation (8) in a single term as the product of bubble velocity and bubble diameter. With this product as a constant parameter, Equation (8) is represented graphically in Figure 2 as a function of bed average particle size for three selected combinations of bed depth and superficial velocity. The heavy solid line represents an upper limit of surface area corresponding to static bed density and no by-passing as represented by Equation (7). For comparative purposes, the dotted lines represent the region of C_{eff} factors corresponding to the range of particle sizes (approximately 3000 microns) used in moving bed cracking processes. This region of C_{eff} factors, over the range of particle sizes used in FCC processes, intersects the parameters of Figure 2 at the values of V_BD_B normally encountered in fluid bed operations.

In other words, Figure 2 indicates that the relative effectiveness of gas-catalyst surface contact, and hence conversion, should not be expected to be far different for FCC and TCC operations. However, it would appear that the fluid process has far greater potentials in view of the excess available catalyst surface.

The development problems lie in better utilization of this available surface or, in other words, means of getting to higher values of C_{eff}. Superficially, this appears to be possible from Figure 2 by any of several means such as increasing bed depth, decreasing V_BD_B, increasing particle size, or altering particle or gas densities to increase v_{mf}. However, the parameters of Figure 2 are not independent variables. For example, as bubbles rise through a fluidized bed, they grow in size so that the product V_BD_B is a function of bed depth. The increase in C_{eff} with bed depth is lost by the corresponding increase in V_BD_B. Similarly, increasing particle size or density also increases V_BD_B and again negates any gain in C_{eff}. The only prime target appears to be means of effectively reducing V_BD_B, the bubble characteristics, or introducing other means of effecting better gas-solids contact.

Applied Fluid-Bed Reactor Designs. The petroleum industry still represents to date the major field of application of the so-called unit operation of fluidization. The major portion of fundamental and applied research in fluid-solids behavior has stemmed specifically from catalytic cracking operations wherein nearly every region of two-phase fluid-solid flow is encountered.

Figure 3 is a schematic illustration of the early two-vessel side-by-side fluid catalytic cracking units and Figure 4 illustrates a modern Orthoflow converter. In both these designs, the oil feed vapors carry hot regenerated 20 to 180 micron diameter catalyst particles in a dilute phase carrier line into a fluidized bed in the re-

TABLE 2—Some Typical Applications of Fluidization

Process		Reference
Fluidized Constant High Temperature Bath	Adams, C. E., et al	Ind. Eng. Chem. **46**, 2458-60 (1954)
Humic Acid by the Fluidized Oxidation of Tandur Coal	Agarwal, D. P., Iyengar, M. S.	J. Sci. Ind. Research **12B**., 443-6 (1953)
Fluosolids Roasting of Zinc Concentrates for Contact Acid	Anderson, T. T., Bolduc, R.	Chem. Eng. Progress **49**, 527-32 (1953)
Bibliography of the Fischer-Tropsch and Related Processes	Anderson, H. C., et al	U. S. Bur. of Mines Bull. 544 (1955)
Fluid Bed Phthalic Anhydride Plants	Anonymous	Chem. Week, p. 40, February 23, 1952
Fluidized Solids Find New Uses in Fire Protection	Anonymous	Chem. Engrg. p. 160, February, 1951
Ethylene Oxide Produced in Fluid Catalyst Bed	Atlantic-Vulcan	Chem. Processing **16**, No. 2, 42-3 (1953)
Fluid Coking and Fluid Coke	Barr, F. T., Jahing, C. E.	Chem. Eng. Prog. **51**, No. 4, 167-74 (1955)
Fluidized Condenser	Beck, C. B., et al	M. S. Thesis, M.I.T., June, 1952
Fluid Bed for Adsorption Separation of Gases	Campbell, D. L., et al	U. S. Patent 2,446,076; July 27, 1948
Carbonization and Drying by Fluidization Technique	Charvat, V.	Paliva **34**, 179-82 (1954)
Distillation of Fluidized Hardwood	Dimitri, M. S. et al	Chem. Engrg. **55**, No. 12, 124-5 (1948)
New Fluid Bed Sulfuric Acid Plant	Dorr Co.	Chem. Engrg. **62**, No. 8, 288-91 (1955)
Sulfur Dioxide by Fluidization	Dorr Co.	Chem. Engrg. **60**, No. 1, 238-41 (1953)
Reduction of Fluidized Solid Molybdenum Trioxide	Dunoyer, J. M.	Proc. Intern. Symp., Gothenburg **1952**, 411-19
Fluid Char Adsorption Process	Etherington, L. D.	Chem. Eng. Prog. **52**, No. 7, 274-80 (1956)
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Transportation of Solids by an Air Slide Conveyer	Mori, Y., et al	Chem. Eng. (Japan) **19**, 16-22 (1955)
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actor. The feed gas is cracked to lighter constituents, leaving a carbonaceous deposit on the catalyst, and then passes from the reactor to the recovery system. The cooled, carbon-coated, catalyst passes from the reactor into the regenerator via a standpipe. The regenerator bed is fluidized with a preheated air stream which burns off the carbon on the catalyst. The hot regenerated catalyst is again recycled to the reactor via the feed oil vapors.

Even exclusive of the petroleum and petrochemical fields, a complete list of patent applications and articles written on applied fluidization would require several pages. Table 2 represents a greatly condensed list of some of the suggestions investigated to date.

In the metallurgical process industries, many of the problems which faced the petroleum applications of this new unit operation have never arisen. For example, the feeding of ore, limestone, etc. into fluo-solids reactors has been accomplished directly by means of screw feeders or high density liquid slurries; regeneration steps and the attendant solids transfer from vessel to vessel is not required.

One of the more interesting developments which originated with fluidized calcination is the technique of pelletization. Pelletization is accomplished within the fluid bed by the addition of small amounts of soda ash or caustic soda. These materials melt at the temperature levels employed and the sticky surfaces of each pellet become coated with the bed fines and thus cause growth of the pellet. By controlling the proportion of finer pellets fed, the rate of pellet growth can be controlled. This technique has permitted as much as a ten-fold increase in gas throughput. The pelletization technique has reportedly been adapted to the fluidized roasting of pyrrhotite permitting a reduction in required reactor area by a factor of about four, and a five-fold reduction in elutriation or carry-over.

It is interesting to note that Jonke[11] presented a paper on the fluidized technique for treatment of aqueous nuclear wastes by calcination to oxides, in which a sort of reverse pelletization procedure is employed. Liquid wastes containing $Al(NO_3)_3$, HNO_3, $NaNO_3$ and $Hg(NO_3)_2$ are pumped into a liquid fluidized bed of aluminum oxide particles. The liquid is evaporated and solid $A10_2$ is formed. The particles are withdrawn at the bottom of the bed as fast as they are formed. The bed is periodically seeded with small particles of $A10_2$ to keep the equilibrium bed particle size at a sufficiently low value to maintain bed fluidity.

Figure 5 illustrates one of the early Fischer-Tropsch fluid bed synthesis reactor for converting carbon monoxide and hydrogen to hydrocarbons and by-product chemicals used in what is now the Amoco Chemical plant at Brownsville, Texas. The reactor, in its commercial-scale form, could only give conversions of the order obtained in fluid catalytic cracking reactors; however, the plant design, and its profitable operation, was based on higher laboratory-scale conversions. This eventually necessitated shutdown, and a complete process and reactor revamp program. This is a typical example of the difference in gas-catalyst contact obtained in a large diameter, shallow bed, bubbling reactor, and that obtained in narrow diameter, high depth to diameter ratio, slugging laboratory pilot plants[15] where complete gas-catalyst contact occurs when the catalyst slugs shower down through the gas.

Figure 6 is a schematic outline of a conceptual design

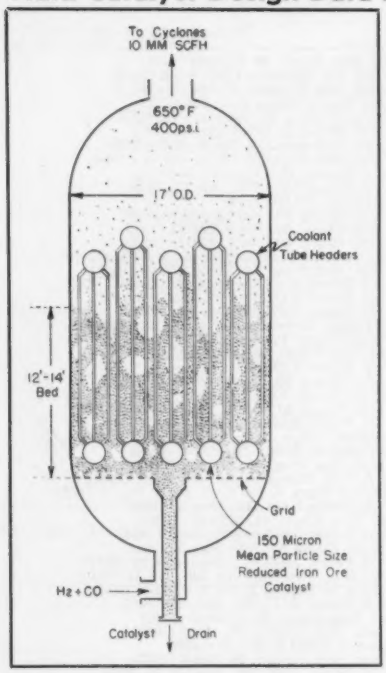

FIGURE 5—One of the early Fischer-Tropsch fluid bed synthesis reactors for converting carbon monoxide and hydrogen to hydrocarbons and by-product chemicals used in what is now Amoco Chemical plant at Brownsville, Texas.

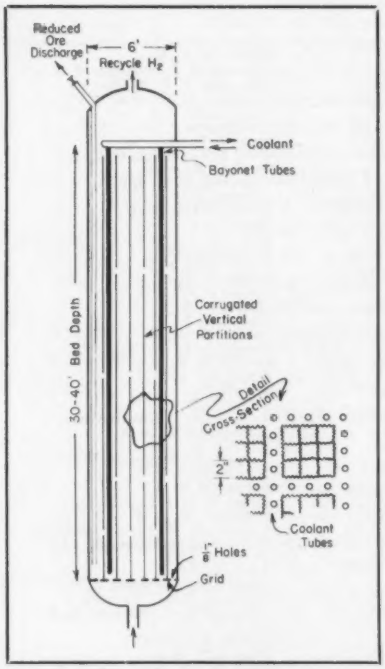

FIGURE 6—Conceptual design of a batch fluidized ore reducer incorporating the advantages of parallel high L/D bed operation. The bed partitions are corrugated to provide greater strength and cooling surface.

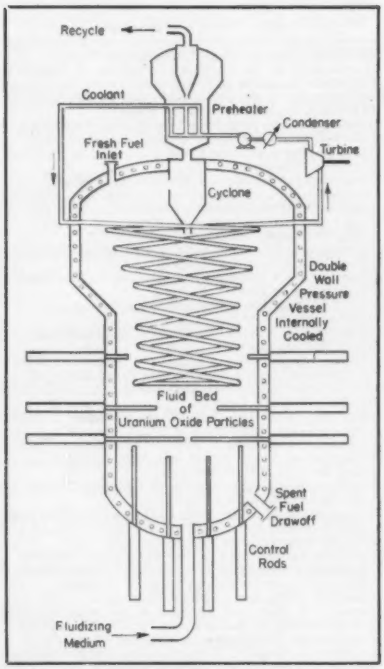

FIGURE 7—A possible fluid bed nuclear reactor design employing one process stream to remove fission products and maintain bed fluidity and another that circulates through a reactor cooling coil and a gas-turbine generator set.

for a fluidized iron ore reduction unit. The principles of this design are discussed in the patent literature,[4,8,17] and follow the philosophy of Table 1. The reactor as a whole is merely a bundle of approximately 2 inches to 4 inches diameter high L/D reactors in parallel. At the specified L/D, the beds will be in slug flow, thus approaching 100 percent contact with the catalyst lying between the top of the channels and a point about 2 feet above the grid where slugs will first be fully developed. Uniform gas distribution to each bed is assured by a high pressure drop grid having, for example, a single ⅛ inch hole below each bed. The bed partitions are corrugated to provide greater strength; the coolant surface can be provided by means of bayonet tubes. An iron ore reduction unit of such design would operate batchwise on about a 24 hour cycle at pressures in the neighborhood of 400-500 psia. The use of fluidization in iron ore reduction is referred to in Table 2.

Figure 7 illustrates a conceptual fluid bed nuclear reactor design[18] employing one process stream to remove fission products and maintain bed fluidity, while the other circulates through a reactor cooling coil, a gas turbine-generator set, a condenser, and then back to the reactor via a preheater. The use of a fluid bed core of particle-form fissionable fuel has the distinct advantages of complete freedom in the arrangement of the control rods and ease of addition of fresh fuel or withdrawal of the burnup. The fluidized fuel is in the form of uranium oxide or uranium carbide particles with hydrogen, helium or deuterium as possible fluidizing media.

About the Author

Frederick A. Zenz is manager, Process Department for Walter Kidde Nuclear Laboratories, Inc. He received his B.S. degree from Queens College in 1942, and his M.S. degree in chemical engineering from New York University in 1950. He is presently completing the requirements for a Ph.D. degree in engineering science from Polytech Institute of Brooklyn. Zenz has had 14 years of varied process and development experience in the industry. He has published more than 20 papers on distillation and multiphase flow, including a chapter in the book on "Fluidization" edited by Othmer. He has been a lecturer on fluid flow in the graduate division of New York University, and has also done part-time consulting.

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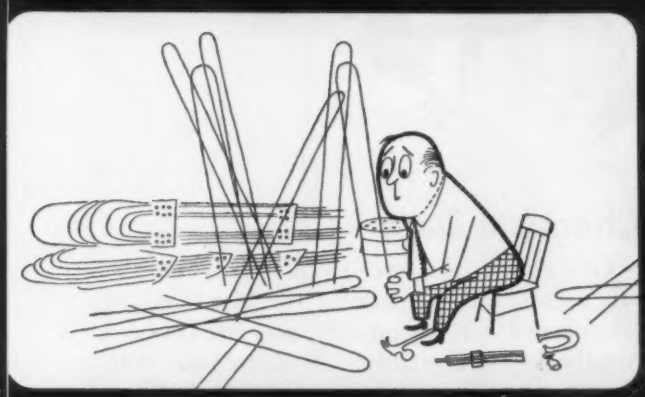

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The maintenance problem in a refinery of any size is complicated by the large number of pumps, compressors and blowers of many different types and designs that are used. The pumps, handling a wide variety of products over a broad range of temperatures, are probably the most troublesome maintenance item from a standpoint of service life of component parts.

Royalite Hi-Way, Ltd., has tried many base materials and surface coatings in efforts to improve service life, with varying degrees of success. In the final analysis, there was no doubt that greatest long-range economy is achieved by hard-racing the components subject to the greatest wear with a nickel-base hard-facing alloy containing chromium boride crystals.

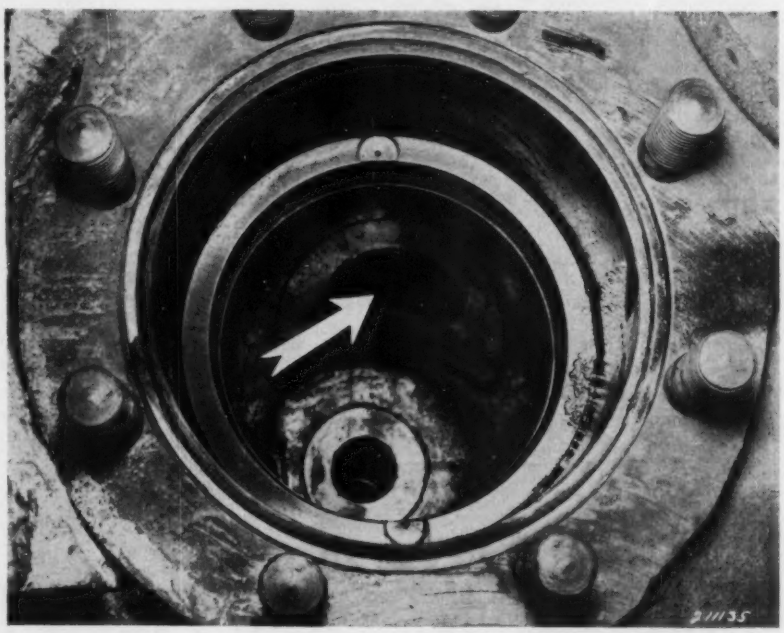
Hard-Facing Experience. Their earliest experience with the above-mentioned hard-facing alloy was on liquid end piston rods for a duplex reciprocating pump in preflash reflux service. This is a straight run gasoline and prior to the use of hard-facing, it had been necessary to repack the pump every two weeks and to install new piston rods every two months. Maintenance costs for both packing and rods amounted to $32.00 over the life of the rods, or $16.00 a month.

As an experiment, Royalite installed a pair or rods hard-faced with the nickel base alloy containing chromium borides in January, 1953 at a cost of $40.00 each. These rods are still in service and the pump is repacked on semi-annual shut-down only. The direct and obvious saving in maintenance costs in this case exceeds $600 to date, and this does not take into account additional savings accruing from reduced packing gland lubrication and reduced loss of product through leakage at the glands when rods become worn.

About three years ago, the thermal cracking plant was converted to Visbreaking. The company installed an 8-inch x 4-inch x 12-inch hot oil duplex pump in vacuum tower bottoms service. The pump was equipped with nickel alloy cast iron cylinder liners. This service is tough for any cylinder liner material because of the high viscosity, corrosiveness and high temperature (650 F) of the residium that must be pumped.

A month after starting up, the pump no longer functioned. This was a costly occurrence. Having no stand-by for this service, it was necessary to shut the plant down. On inspecting the pump, it was found that the cylinder liners were corroded beyond repair. Because of previous success with hard-facing, the company decided to obtain replacement liners having a sprayed and fused hard-face overlay of the same material used on piston rods.

The hard-facing alloy was applied in powder form by spraying. It was then heated with an oxy-acetylene torch to form a fusion bond with the base metal. It was impossible at that time to spray the inside of so small a cylinder, so half-shells were made and installed in the liner. These liners were still functioning satisfactorily a year later, but it was found that the hard-facing alloy had chipped slightly



Shiny hard-faced liner for a reciprocating pump shows no effects of corrosion or wear after a year's service.

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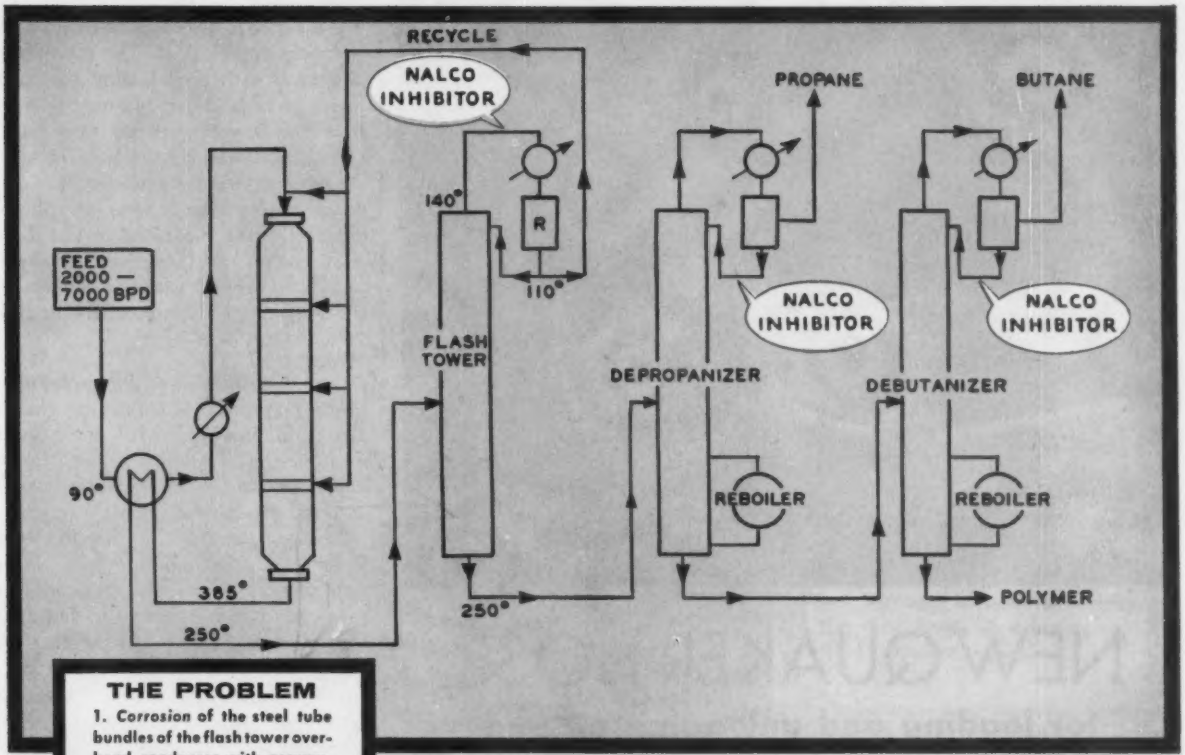

THE PROBLEM

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2. *Serious fouling* of screen trays in the depropanizer and debutanizer on normal six-month run.

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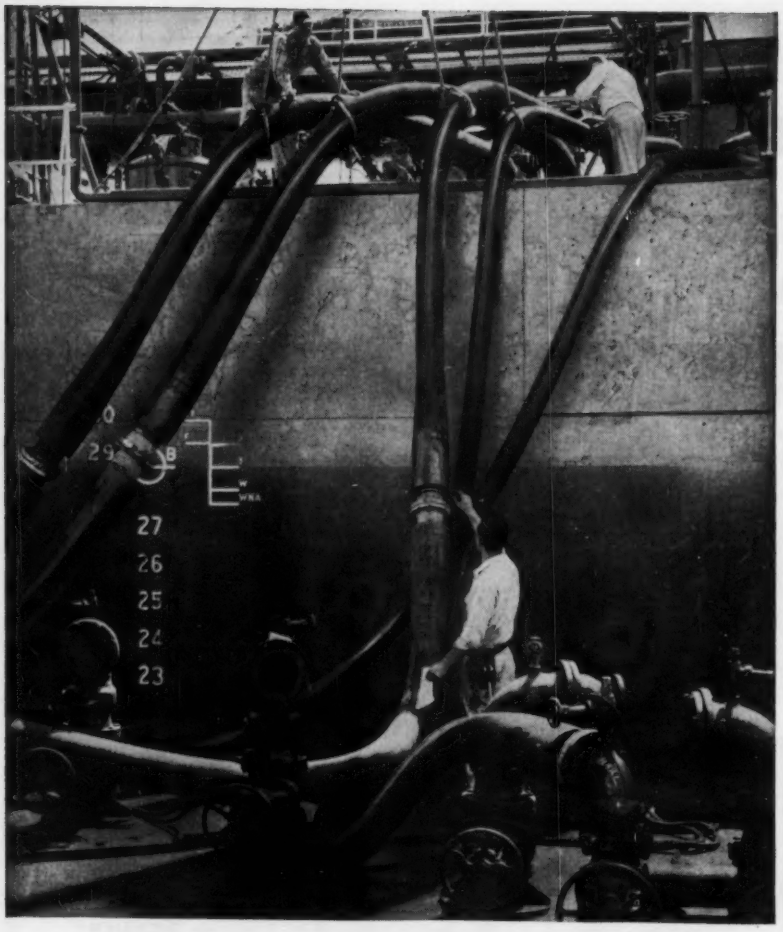

where the half-shell joints came together. By this time, a method had been devised to permit spray hard-facing of these liners in one piece. A new pair was made and installed. After more than a year, they are still in excellent condition.

A larger pump was purchased for the Visbreaking vacuum tower bottoms service in December, 1955. This is a 10-inch x 6-inch x 12-inch reciprocating duplex unit. The pump was delivered with nickel alloy cast iron liners which again lasted only a month. The replacements were hard-faced liners which have been in service over a year with no obvious evidence of corrosion or wear, see photograph. Despite the initial cost of these components, the long life achieved produces very substantial savings in the long-range maintenance cost picture.

Other Applications. All centrifugal pumps equipped with packing glands are now provided with hard-faced shaft sleeves. They are giving greatly improved packing life, reduced leakage and much less down time.

The company has recently installed in its refinery gas compressors, piston rods protected with the same nickel-base hard-facing alloy containing chromium borides. It is still too soon to say how long these rods will last, but it is found that there is a much better seal through the gland than previously. The extremely low coefficient of friction provided by this particular hard-facing alloy should give much longer wear on segmental packing, which is a very expensive item. Cost of packing alone for the three compressors amounted to more than $700. The company also uses, in electrode form, an iron-base alloy containing chromium boride crystals to build up the slide valves in the cat cracking unit. Company maintenance policy now calls for use of this

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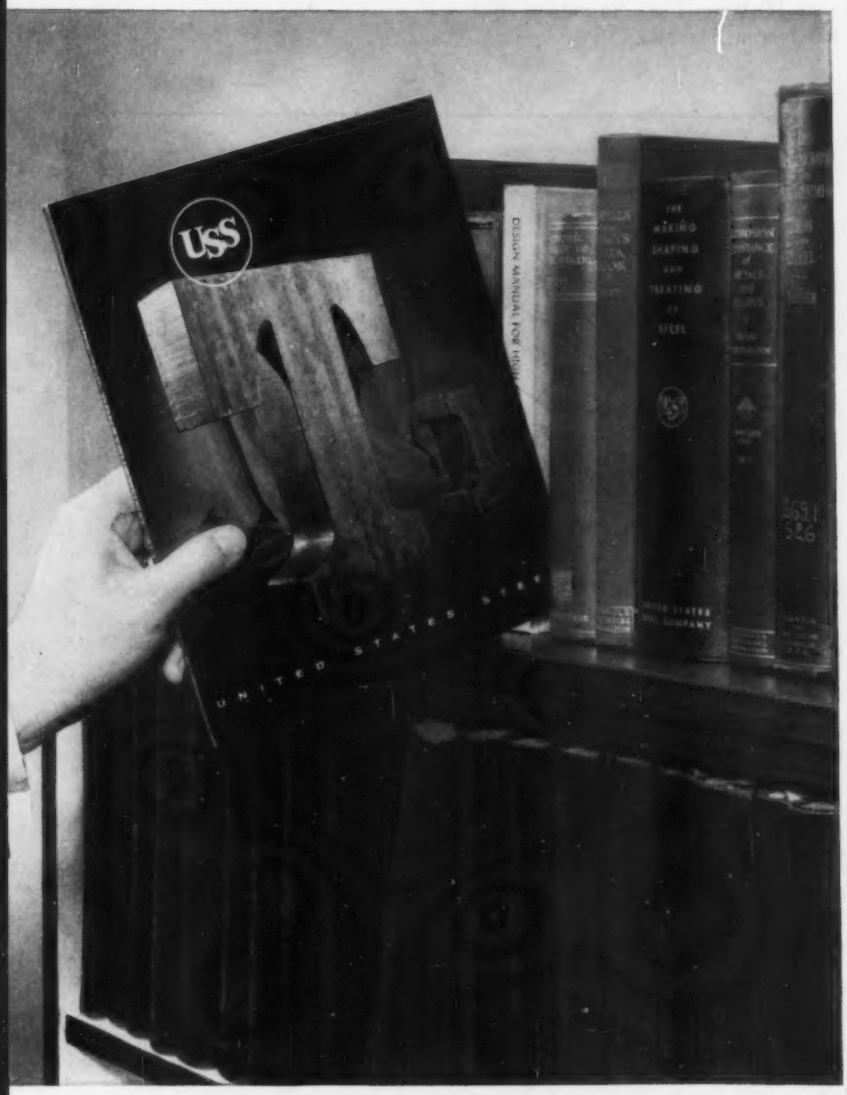

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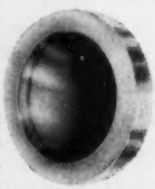


You should use these glasses whenever you work with materials under heat and/or pressure. They withstand high temperatures and sudden changes of temperature, and will remain transparent through a long service life.

PYREX mold finished glasses are recommended for use when pressures are low or low pressures are accompanied by high temperatures.

PYREX annular edge glasses are designed for use on pressure vessels. They will safely withstand pressures up to 450 p.s.i. and temperatures up to 500 F.

There is a PYREX sight glass to fit your particular application. Let us send you a copy of Bulletin EB-20, which describes the properties, specifications and application of these glasses.

Corning means research in Glass

CORNING GLASS WORKS
CORNING, N. Y.

Please send me a copy of Corning Sight Glass Bulletin EB-20.

Name.....

Company.....

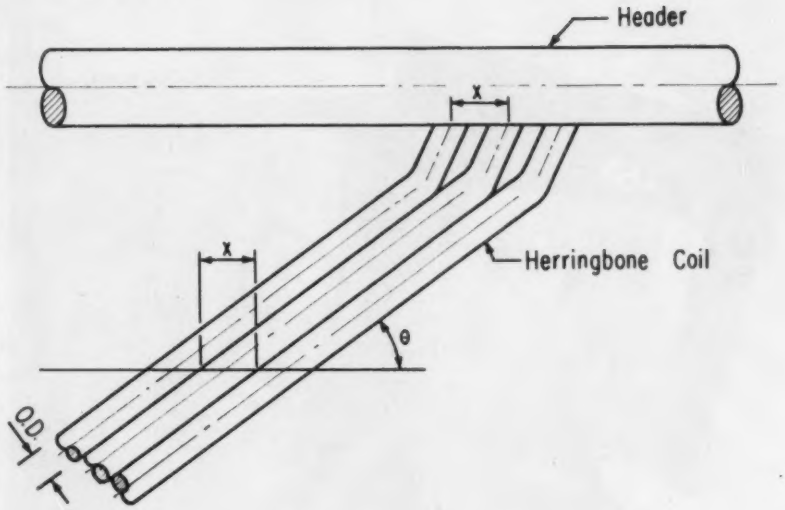
Address.....

City..... Zone..... State.....

family of effective hard-facing materials wherever wear is excessive.

Item submitted by:
F. Robin, Chief Power Engineer, Royalite Hi-Way, Ltd., Saskatoon, Saskatchewan, Canada.

How to Do It . . .



A Simplified Evaporator Coil Formula

A herringbone type evaporator is sometimes used to chill brine in the brine tank of a dewaxing unit.

The following formula is applied to calculate the minimum pitch between two adjacent herringbone coils: Let

D = outside diameter of herringbone coil

X = minimum pitch between two adjacent coils

θ = slope of herringbone coil

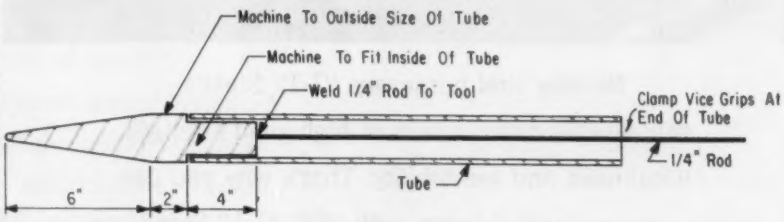
then:

$$X = \frac{D}{\sin \theta}$$

Example: For 1½ inch pipe, D = 1.9 inches. Assume θ = 12 degrees, Sin θ = Sin 12 degrees = 0.2034 therefore:

$$X = \frac{1.9}{0.2034} = 9.3 \text{ inches}$$

Item submitted by:
Y. N. Fan
Berkeley, California



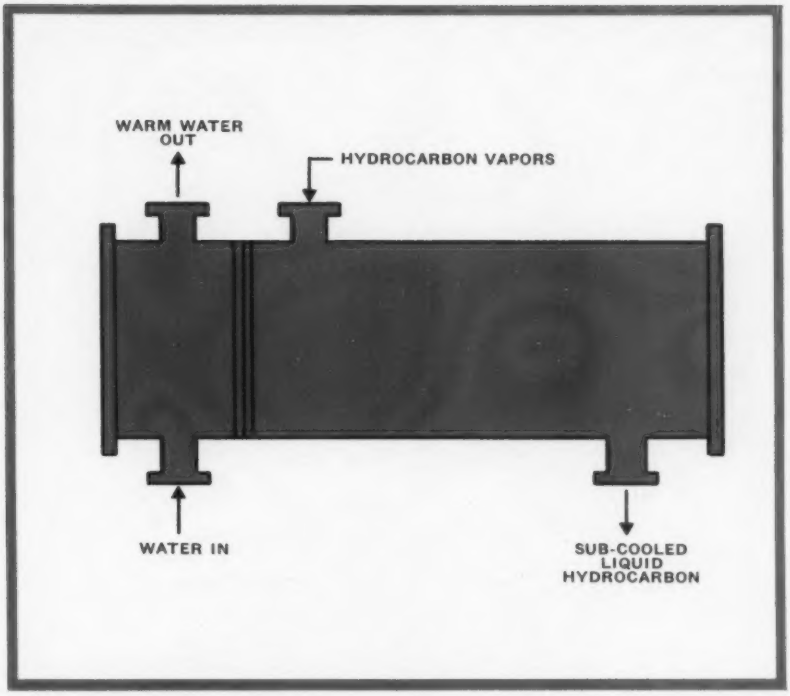
Tool Simplifies Heat Exchanger Retubing

Heat exchangers often have a number of internal spacers or baffles. When retubing, it's often a problem getting the 20 foot tube lengths to enter the baffles easily.

The figure shows a tool which was designed to simplify this problem. A steel rod is turned to the tube O.D. and tapered. A shoulder is cut, as shown, to the tube I.D. and a quarter-inch rod is welded to the tube head.

After inserting the tool into the tube, vice grips are attached to the

For more data on advertised products, use Readers' Service Cards, last page.



SAVES MONEY, TOO:

Use of WOLVERINE TRUFIN® Boosts Condenser Heat Load

By Ernest Dodd

Throughout industry—wherever heat transfer is a necessity—more and more engineers are finding that the answer to increased heat transfer performance lies in the use of Wolverine Trufin Type S/T—the integrally finned condenser tube.

As another perfect example of this, consider the results obtained by processing engineers in a large Eastern refinery, when they retubed a hydrocarbon side cut condenser with Wolverine Trufin Type S/T.

In its prime surface form the unit required 476 tubes ¾" O.D. in 16' lengths. When retubed with Trufin Type S/T, exactly the same number of tubes of the same length and O.D. were used. *Heat duty, however, immediately shot up by 30 to 35%—a gratifying increase indeed.*

There is no particular secret or magical formula connected with Trufin's ability to extract more BTU's per foot of tube. Its success is in its extended surface—gained through its integral fins which are actually extruded from the tube wall. Because of these fins, Trufin has approximately 2½ times more outside surface area than does an equivalent piece of plain tube. More outside surface area, of course, means that you can pack more heat transfer surface into a given space thus boosting the heat performance of existing units.

In addition to boosting capacity, Trufin Type S/T also saves you money. Because it is completely interchangeable with plain tube there is little unit modification required — you simply insert Trufin condenser tubes into the bundle and roll it into the tube sheet in the regular manner, using standard tools and retubing techniques.

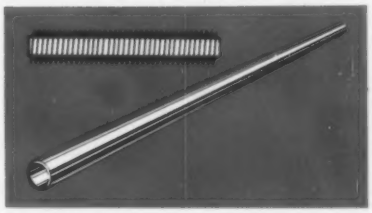
Here's a sure-fire method for boosting throughput, saving space and cutting costs—all at the same time.

If your company hasn't as yet used Wolverine Trufin Type S/T condenser tubes why don't you suggest them.

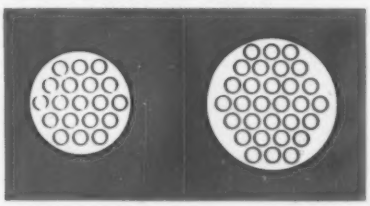
HERE'S THE WAY TRUFIN TYPE S/T HELPS YOU SAVE

You know what they say—about a good picture taking the place of a thousand words. Well, most of the time we don't agree with this—but the three drawings below are the exception to the rule. Look them over and see for yourself exactly how Wolverine Trufin Type S/T can help you improve heat transfer performance.

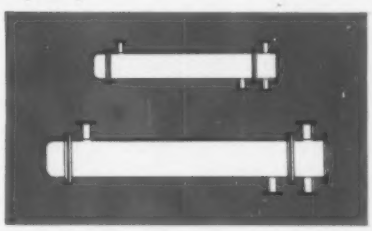
This much Trufin has the same surface area as this much plain tube...



Which means smaller shells . . .



And smaller units with greater capacity



NEW BOOK—FREE!

Wolverine's new "Comparative Heat Exchanger Costs Book" is well worth adding to your heat transfer file. Prepared by experts it graphically presents cost breakdowns and actual comparisons between the use of plain tube and integrally finned tube in the design of heat transfer equipment. Write for your copy—TODAY!

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WOLVERINE TUBE DIVISION
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CANADA VULCANIZER AND EQUIPMENT COMPANY LIMITED

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Believe it or not...

it's integral!

Varying temperatures . . . fluctuating pressures . . . constant vibration. None of these can affect the inherent stability of Wolverine Trufin® —the one-piece, finned condenser tube.

The fins of Trufin are squeezed right from the tube wall, are completely integral with the tube itself. That means longer on-stream time—more "mileage" when the going is tough.

Trufin can step up the capacity of your existing unit, when revamping, or can permit the design of a smaller unit (with a bigger punch!) when new heat exchangers are considered. Replace prime surface tube with Trufin Type S/T (low finned) in water-cooled condensers. Specify Trufin Type H/R (high finned) for air-cooled applications. Investigate the Trufin story—NOW! Write for the Trufin Catalog.

Wolverine Trufin is available in a wide range of sizes and types in copper, copper-base alloys, aluminum and electric-welded steel.

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario

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How to Do It...

quarter inch rod at the free end, and the tube becomes a probe with a tapered nose for easy insertion.

Item submitted by:
Mell Hill
Canadian Chemical Company, Ltd.
Edmonton, Alberta, Canada

You'll Want to Save this Cylindrical Conversion Chart

Gallons	Diam. Inches	Length Feet	Insul. Surface Sq. Ft.
30	18	2	14
66	20	4	28
85	20	5	33
100	24	4	35
120	24	5	41
140	24	6	48
150	30	4	44
180	30	5	52
220	30	6	61
250	30	7	70
295	30	8	78
315	36	6	75
365	36	7	85
420	36	8	95
525	36	10	115
430	42	6	90
500	42	7	101
575	42	8	113
720	42	10	136
865	42	12	159
1000	42	14	182
750	48	8	131
940	48	10	158
1130	48	12	184
1300	48	14	210
1500	48	16	236
1700	48	18	262

Note: Above units include shell and two heads.

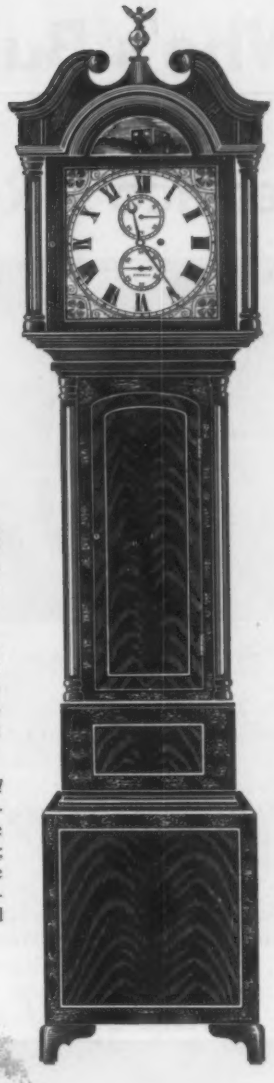
Many times estimators need an aid for quick determination of the amount of insulation required for cylindrical vessels. These vessels are often designed only by gallon size, or by length and diameter.

This chart was designed to eliminate complex mathematical calculations in estimating the amount of insulation required for these vessels.

A quick glance at the chart tells users that a 525 gallon tank will require 115 square feet of material to insulate the shell and both heads, or that a tank 30 inches in diameter and six feet long will need 61 square feet of insulation.

The chart was prepared by the Armstrong Cork Co.

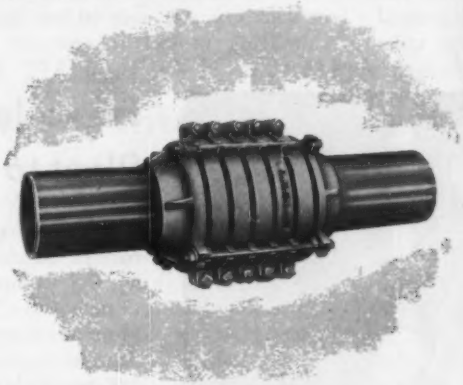
19,862 years of precision metal-forming



When you specify FLEXON® Expansion Joints, you actually *buy time*—19,862 years of combined experience in the team of engineers, metallurgists, and technicians who produce Flexon Expansion Joints!

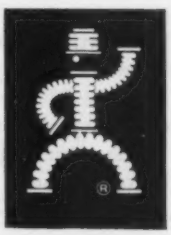
And all this time has been invested in perfecting formed and corrugated tubular shapes in metal, made with watch-like precision—flexible metal hose, instrument-type bellows, "impossible" bends and section modulations for aircraft parts . . . **and expansion joints of every kind.**

So—for expansion joints that you can *install and forget*—always specify FLEXON. Free-flexing and controlled-flexing; dual and multiple types; balanced joints and other special designs; all in stainless steel, monel, and other workable alloys. Assured longer service life, through careful analysis of your application plus unmatched skill in manufacture.



Write today for your copy of the Flexon Expansion Joint Design Guide—28 pages of facts about absorbing pipe motion.

EJ-210



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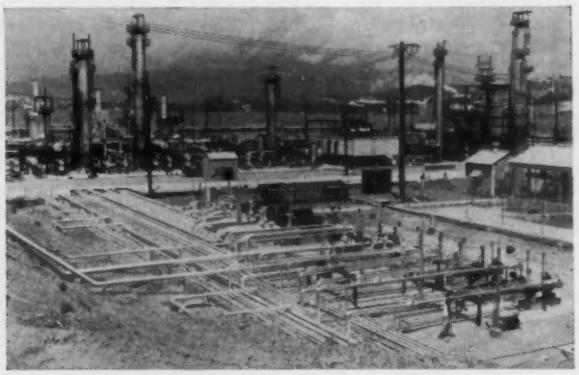
Who's Building . . .

Texaco's Refinery On Stream in Cuba

Aerial view of refinery, storage tanks, and dock loading facilities.



General processing area of Texaco's new 20,000-bpd refinery.

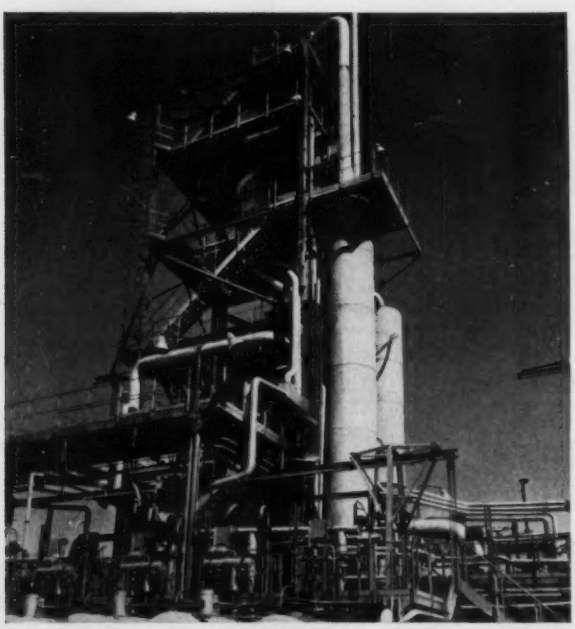
The Texas Co. has announced that its new refinery at Santiago de Cuba has begun operations. The refinery, which has a rated crude capacity of 20,000 bpd produces gasolines, kerosine, diesel oil, fuel oil, and liquefied petroleum gas.

H. T. Dodge, Texaco vice president in charge of foreign operations (Western Hemisphere and West Africa), said that the refinery is located on a 400-acre site about three miles south of Santiago de Cuba. A first-class road from the city to the refinery has been completed. The installation, which is estimated to have cost over $15 million, includes a gasoline treating unit, a catalytic reforming unit, a liquefied petroleum gas unit, and a hydrotreater. Tank capacity is about 1.4 million barrels.

The installation includes a 1000-foot dock in water over 40 feet deep. A dredging project is expected to open Santiago's harbor for the first time to ships drawing up to 40 feet.

Charles M. Cutbirth is superintendent of the new refinery. He was formerly superintendent of the Vengref refinery in Venezuela.

Texaco has been marketing fuel oil and lubricants in Cuba for nearly 40 years. The country consumes about 60,000 barrels of petroleum products per day.



Process plant at Francolor's new installation.

Francolor Finishes First French Plant to Make Maleic Anhydride

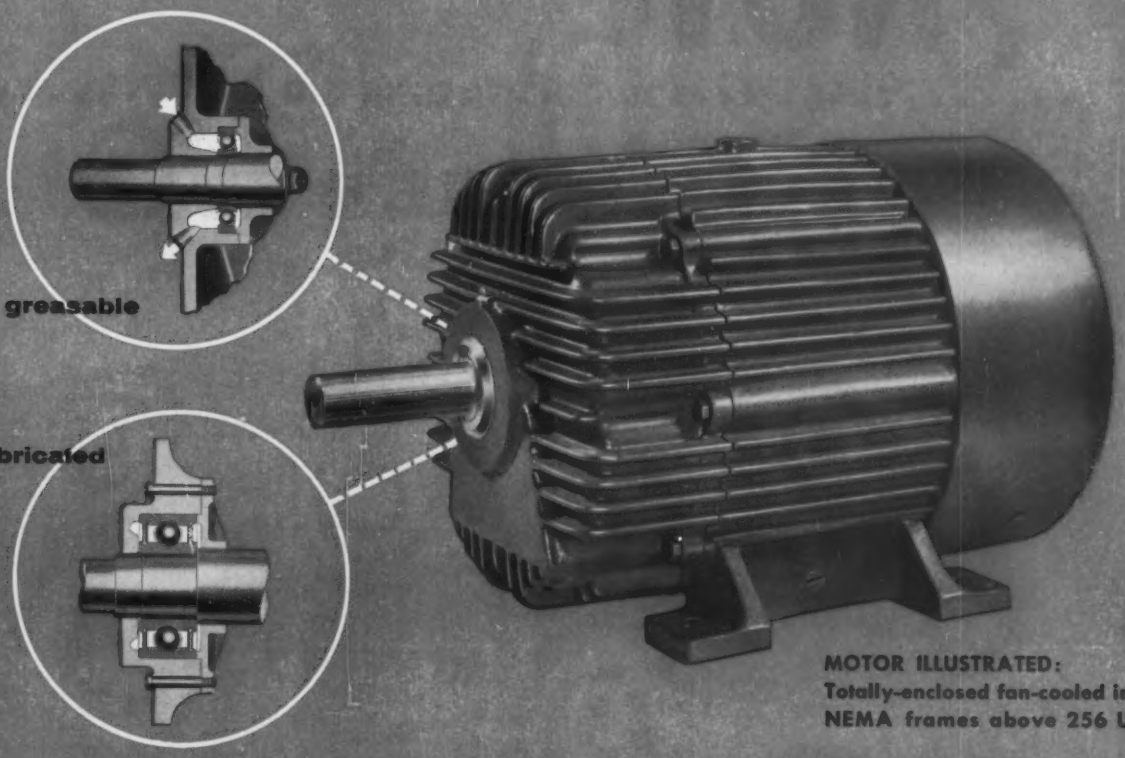
The first commercial French plant for the manufacture of maleic anhydride was recently placed on stream by the Compagnie Francaise des Matieres Colorantes (Francolor). This unit is presently in full operation at Francolor's dye-works located at Villers-St. Paul, about 30 miles north of Paris.

Francolor's production is marketed to the French chemical industry as an intermediate for use in the production of plastics, alkyd resins, polyesters for glass reinforced plastics, and agricultural chemicals.

The plant, rated at approximately 2.2 million pounds per year, was designed by Scientific Design Co., Inc., New York, and uses a process developed by SD involving a special patented catalyst and novel design features. Facilities for the manufacture of the catalyst by Francolor were also designed by SD.

The plant represents a radical departure from present European technology for plants of this type (such as phthalic anhydride), due to its novel heat transfer sys-

YOUR CHOICE of motor bearings . . .



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Whatever your operating conditions or maintenance practice, Crocker-Wheeler offers the motor bearing best adapted to your needs or preference.

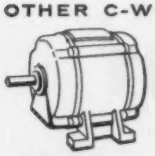
The Open Greasable type
requires only infrequent lubrication. All old grease is positively flushed out, eliminating risk of forcing grease into motor interior. An external grease reservoir helps seal and protect the bearing. The inner cap and grease reservoir prevent rust or corrosion from within.

Prelubricated bearings
are furnished for applications requiring operation without regular service lubrication. They are sealed cartridge-type, factory grease-filled, with inner protective cap.

Choice of bearings
is another design feature of the new Elliott Type N motor line. These motors are honestly new—inside and out. We think you'll agree that they incorporate every important feature that distinguishes a modern motor.

W7-1

OTHER C-W TYPE N MOTOR ENCLOSURES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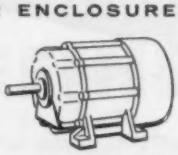
Dripproof Protected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ELLIOTT Company
CROCKER-WHEELER DIVISION
Jeannette, Pennsylvania

We will be glad to send a copy of this new booklet describing the complete line of Elliott C-W type N motors. Ask for Bulletin PB 6000-6.

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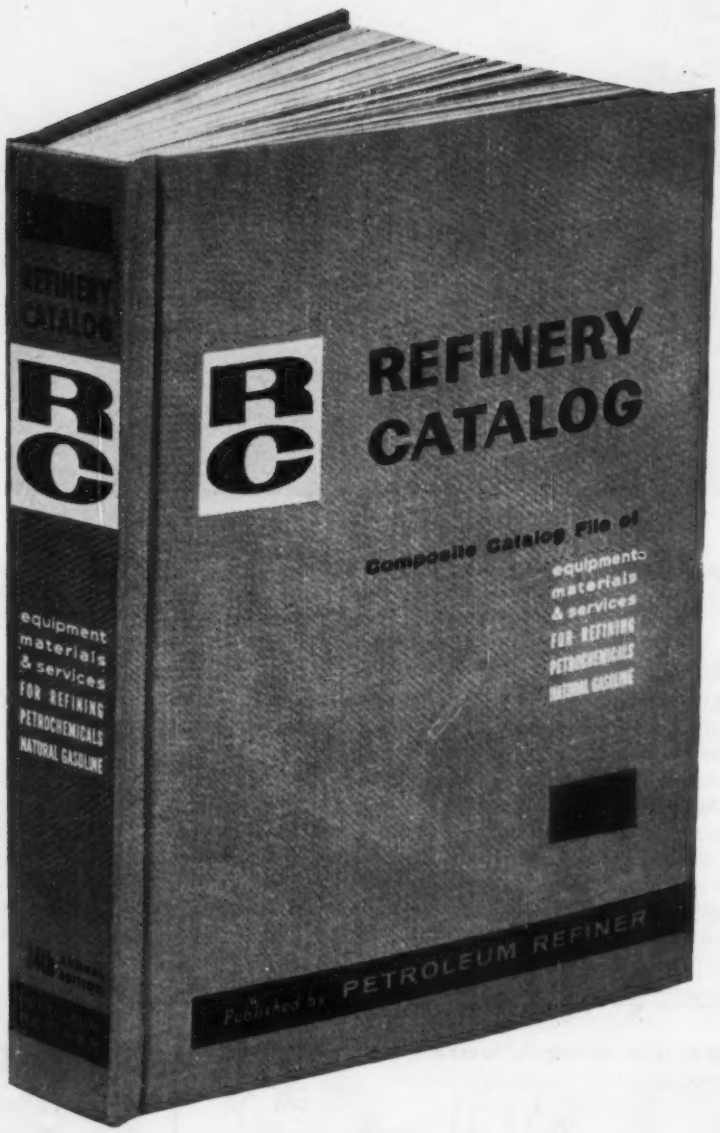
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Who's Building...

tem, and its out-of-door type of construction.

The SD process involves the continuous, catalytic, vapor-phase air oxidation of benzene. Vaporized benzene and air are preheated and passed to a multitubular catalytic reactor.

The hot reactor effluent gases pass through coolers for the recovery of heat by generation of steam and by preheating feed gas. These gases then go to a water scrubber where maleic anhydride is absorbed, forming maleic acid. The maleic acid solution is pumped to a dehydrator which regenerates maleic anhydride. Only a minimum of maleic is transformed to isomeric fumaric acid in the dehydration step, by careful control of conditions. The crude maleic anhydride is purified in a refining column, then pelletized and packaged.

The Francolor plant is the second major maleic anhydride plant project to be executed by SD. SD's initial project was completed in 1954 when the maleic plant of Reichhold Chemicals, Inc. at Elizabeth, N. J. went on stream with a revamped reaction system utilizing the SD catalyst.

American Oil Co. has announced that a new Ultraformer, second unit of its kind at the company's El Dorado refinery, is on stream.

The new unit has a capacity of 6200-bpd. The first Ultraformer at El Dorado is rated at 5600-bpd, giving the Arkansas refinery a total daily Ultraforming capacity of 11,800 barrels.

The first El Dorado Ultraformer went on stream in May, 1954.

The El Dorado refinery, one of six operated by American Oil, processes 43,000 barrels of crude a day into such products as gasoline, kerosene, jet fuel, home heating oil, weed killer, pressure tar, coke, polybutene and LPG.

National Petro-Chemicals Corp. has chosen Houston as the site for its second polyethylene plant. Plans for building the plant were previously announced, but the site had not been chosen at that time.

The new 75 million pound-per-year plant will be located on a 200-acre site on the Houston Ship Channel, in an area which has been set aside for industrial development by Phillips Petroleum Co., not far from the San Jacinto monument. High-purity ethylene will be supplied by Phillips under long-term contract from its new ethylene plant at Sweeny, Texas. Phillips will also supply the natural gas requirements of the plant.

The new polyethylene plant is scheduled for operation for late 1958. M. W. Kellogg is handling the engineernig and construction of the plant.

The new plant will produce 75 million pounds-per-year of intermediate-density polyethylene resins by a modificaiton of the conventional high-pressure process which is already in operation at the company's Tuscola, Illinois plant.

National Petro-Chemicals, a subsidiary of National Distillers and Panhandle Eastern Pipeline Co., is now producing polyethylene at the rate of 100 million pounds-per-year at its Tuscola, Ill. plant. The new plant will bring the company's total capacity to 175 million pounds-per-year.

Phillips Petroleum Co. is building a unit at its natural gas liquids processing and refining center near Borger, Texas, which will supply new quantities of very high octane blending materials for its motor fuels. This unit, which will be the first of its kind to go on stream, will catalytically convert normal pentane, a natural gas liquid material with an 85 octane number, to isopentane, which has an octane number of about 105. Isopentane also has clean-burning, high volatility, and other valuable characteristics.

The new unit uses the Penex process for which design and catalyst were developed by Universal Oil Products Co., and is being constructed by Phillips. It will produce 13,500 barrels of isopentane daily. It has been under construction several months and is expected to be completed during the first quarter of 1958.

Gulf Oil Corp. has placed on stream at its Philadelphia refinery, two new Gulfining units which use a hydrogenation process to super-refine home heating oils.

The new units each have a design capacity of 20,000-bpd of heating oil, but are expected to exceed this figure on the basis of performance of two original Gulfiners, which have been operating for several months at Port Arthur, Texas.

The Port Arthur units, built on the same plan as those at Philadelphia, are producing at well above design capacity, the company revealed.

One of the Port Arthur Gulfiners is processing light catalytic gas oil from the refinery's catalytic cracking units at a rate of 25,000-bpd. The other is processing straight run distillate stock at 27,000-bpd.

Further, the Port Arthur Gulfiners are operating at somewhat lower temperature than anticipated, which will serve to extend catalyst life and reduce the frequency of catalyst regeneration.

Gulfining was developed at the company's Research Center near Pittsburgh to utilize hydrogen, produced by Gulf's recently installed catalytic reformers, for the purpose of removing sulfur and other undesirable compounds from fuel oil distillates by hydrogenation.

In the process, the distillate charge stock and hydrogen from the catalytic reformers are raised to a high temperature. The mixture is then fed into the reactors and passed over a catalyst under high pressure.

By the consequent reaction, the virtual elimination of unstable hydrocarbon compounds and other objectionable components is achieved.

Kerr-McGee Oil Industries, Inc., announced that an expansion and improvement program planned for its Cushing refinery got underway with purchase of a complete crude unit from the Tidewater Oil Co. refinery at nearby Drumright, Okla.

The unit will be enlarged prior to installation. Alteration of the crude unit is under study by the Litwin Engineernig Co., Wichita.

When the equipment is modified and ready for use, it will have a daily capacity of 23,000 barrels. The older shell stills of the refinery will be retired; a 7000-bpd unit purchased in 1952 will remain in use. This will boost throughput from the present 22,000 barrels to 30,000-bpd.

Planned modifications of other equipment include installation of a catalytic reformer.

Lion Oil Co. Division of Monsanto Chemical Co. will add a catalytic reformer with thruput capacity of 5000-bpd of charging stock at its El Dorado, Ark., refinery. The installation will also include a hydrodesulphurization unit and a 100,000-pound-per-hour steam boiler.

The reformer will convert low octane straight-run gasoline into higher octane material. Plans have already been submitted for bids.

The location for the new units is within the present refinery area. Site clearance and other preliminary work will start immediately. Actual construction will begin shortly after the first of the year, with completion in the latter part of 1958.

Bay Refining Corp., wholly owned subsidiary of The Dow Chemical Co., will increase its daily crude refining capacity to 15,000 barrels.

Expansion will involve installaiton of a new topping unit for processing crude oil. Completion is expected about Ocotber 1, 1958.

Commerce Oil Refining Corp. has awarded The Fluor Corp., Ltd., a contract in excess of $50 million to design, engineer and construct a 43,000 bpd refinery at Jamestown, R. I.

The installation will cover a 600-acre site on the northern end of Conanicut Island, located in Narragansett Bay, near Providence, R. I.

Designed primarily to produce unusually high octane gasoline, the refinery will employ the latest processes including: pentane isomerization, Unifining, Platforming, alkylation and catalytic cracking. Pollution of the air by undesirable sulfur compounds present in the crude oil will be prevented by converting the harmful compounds into sulfur.

More than 60 percent of its production will be 100 plus octane gasoline, the remainder distillate fuel oils and miscellaneous products.

Offsite facilities will include a 600,000 pounds-per-hour boiler plant, a complete salt water cooling system, tank farm, docks for loading tankers and other facilities.

Fluor has started engineering work on the project and construction is scheduled to begin soon, with completion set for early summer, 1959.

Karachi, Pakistan, was visited by an eight-man technical mission of refinery engineers and marine experts recently. They journeyed to the capital city to examine the technical and economic aspects of a proposed oil refinery with special reference to the selection of a suitable site and marine facilities.

Headed by J. Henderson, refinery engineer of The Burmah Oil Co., Ltd., the team was comprised of T. J. Bijlsma, refinery engineer; R. N. Burnley, economist; and Capt. W. Groom, marine superintendent, all of the Shell Petroleum Co., Ltd.; H. J. Robinson, engineer of Standard-Vacuum Oil Co.; V. A. Raven, refinery engineer, and Capt. E. F. Pointon, marine superintendent, both of Caltex; and Lt. Col. T. M. Oag as marine consultant.

Previously, the government of Pakistan had asked The Burmah Oil Co., Ltd., Shell Petroleum Co., Caltex and Standard-Vacuum Oil Co., to submit joint proposals for the setting up of a refinery. The present technical mission went to Karachi as a result of this request from the government.

On receiving the technical report from

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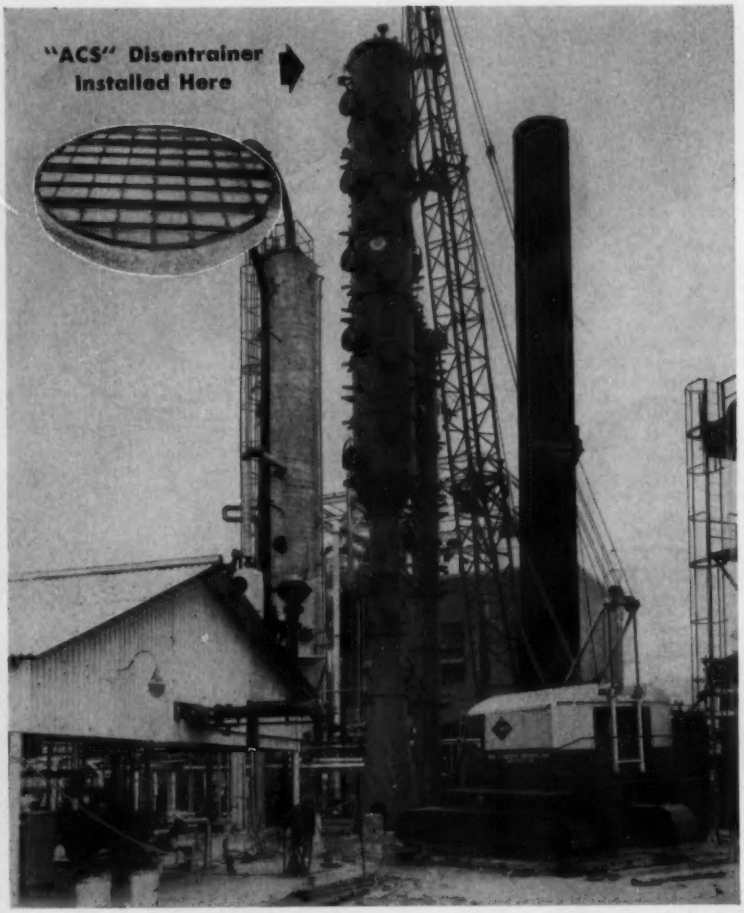

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Who's Building . . .

their experts the consortium will pursue studies for submission of proposals for the refinery to the government of Pakistan.

British Petroleum Co., Ltd., has announced that in Germany, a Hydrofiner has just been commissioned at BP's Hamburg refinery, capable of substantially removing sulphur from 6500 barrels of gas oil a day. Associated with the Hydrofiner is a sulphur recovery plant to produce about 10 tons of sulphur a day. A smaller unit than that at Hamburg has been operating at Kwinana refinery, Western Australia, for two years. Two larger units, one at Kent refinery, England, and the other at Antwerp refinery, Belgium, are due to be commissioned next year.

At BP's Kwinana refinery, Western Australia, a specially designed bottling and bulk filling plant to supply liquid petroleum gas was put into operation recently. The new plant was designed by the refinery's engineering staff.

New storage facilities for motor spirit have been commissioned by BP (New Zealand) Limited at Whangarei, the main town in the North Auckland area. This installation will now be fed by tankers bringing products directly from overseas. Previously all BP motor spirit and other products for the area had to be carried by road tankers from Auckland, about 100 miles away.

BP Benzin-und Petroleum GmbH (British Petroleum Co.'s German affiliate) and **Farbenfabriken Bayer** of Leverkusen may form a joint, 50-50 company to manufacture petrochemicals. Production units, including one already built, will be located adjacent to the Bayer plant at Dormagen, near Cologne. About $56 million will be spent on new facilities according to current plans. A new BP refinery is to be built in the Ruhr area, which will provide about 300,000 tons of petroleum feedstock annually for production of organic semi-finished products at the new petrochemical facilities at Dormagen.

United Rubber and Chemical Co. has commenced a $650,000 modernization program at its Baytown, Texas, plant. It includes new concrete and metal buildings. Process piping and insulation work, mechanical work, and power and electricity work. The plant has a rated annual capacity of 44,000 long tons of synthetic rubber.

Barnhart Hydrocarbon Corp. has completed an expansion of its natural gasoline plant at Big Lake, Texas. Capacity of the plant was increased by 6 MMcfd.

Reef Fields Gasoline Corp. is in the process of expanding its East Vealmoor plant at Big Spring, Texas. By December of this year, an additional 65 MMcfd will have been added to the present capacity of the plant.

Standard Oil Co. (Indiana) has placed on stream a second new large-volume Ultraformer at its Whiting, Ind., refinery. The unit is operating successfully on its first run. Capacity is 21,000 barrels per day.

Steelwork is being raised for a third Whiting Ultraformer, similar to the unit just started up. Whiting Ultraformer No.

IF — LIQUID ENTRAINMENT is your operating problem...

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METEX HI-THRUPUT MIST ELIMINATOR

Proved by innumerable installations in U.S. and foreign refineries, this latest development by the originators of knitted wire mesh entrainment separators:

1. **Will remove and return more than 99% of the liquid carryover.**
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3. **Will have ½ to ⅓ the pressure drop.**
4. **Gives more complete and rapid drainage of de-entrained liquids.**
5. **Has 2½ to 3 times longer on-stream effectiveness under build-up of coke.**
6. **Is lower in cost.**

The increased effectiveness and lower cost of these new Metex Hi-Thruput Mist Eliminators is due to two basic improvements in the knitted mesh structure.

1. The size, shape and framing of the openings in the mesh have been changed to reduce stagnation points and promote freer liquid drainage.

2. Wires are repositioned, after crimping, by our Herringbone Fold, thus giving more impingement surface area per pound of wire.

For full information on this latest development in Mist Eliminators (sometimes called entrainment separators, demisters or crinkled wire mesh pads) write for a copy of Bulletin ME-6. Our engineers will be glad to give specific recommendations on any problem on receipt of information on operating conditions and vessel sizes.

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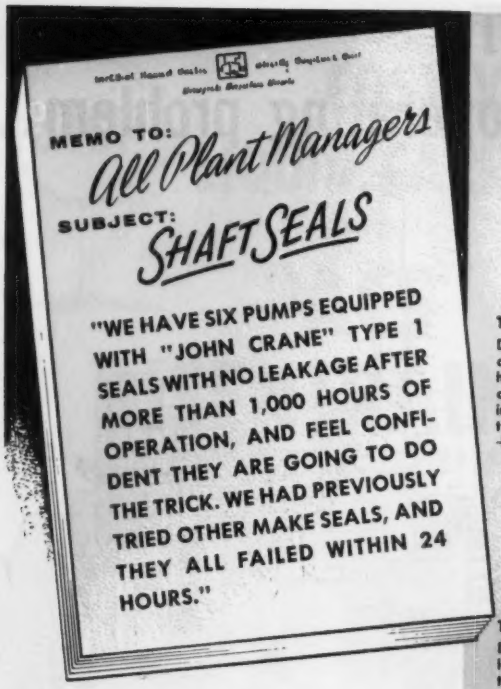
For more data on advertised products, use Readers' Service Cards, last page.


MEMO TO:
All Plant Managers
SUBJECT:
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"WE HAVE SIX PUMPS EQUIPPED WITH "JOHN CRANE" TYPE 1 SEALS WITH NO LEAKAGE AFTER MORE THAN 1,000 HOURS OF OPERATION, AND FEEL CONFIDENT THEY ARE GOING TO DO THE TRICK. WE HAD PREVIOUSLY TRIED OTHER MAKE SEALS, AND THEY ALL FAILED WITHIN 24 HOURS."

This is part of an actual memo sent by one plant manager to others of the same company in different sections of the country—and that company is now exclusively specifying these and other type "John Crane" Shaft Seals for *all* their liquid handling requirements.

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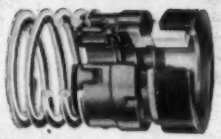
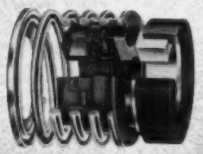


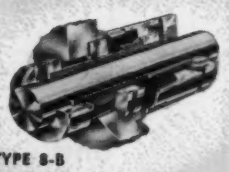
TYPE 1

Designed for limited stuffing box diameter. Handles water, light hydrocarbons, refrigerants, mild acids and other liquids non-injurious to synthetic rubber at temperatures from −40°F. to +212°F., pressures to 200 psi.



TYPE 2

Designed for limited stuffing box length. Handles same services, temperatures and pressures as Type 1.



TYPE 8-B

Heavy duty, high pressures. Packaged construction for easy installation. Handles pressures to 1200 psi., temperatures from −40°F. to +250°F. Services same as Type 1.

TYPE 9

Famous as a problem solver. Sealing members of chemically inert Du Pont Teflon. Engineered to service conditions to handle practically all destructive acids, corrosives and gases at temperatures from −120°F. to +500°F., pressures to 150 psi. Available in balanced construction for pressures to 750 psi.

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Who's Building . . .

1, with a capacity of 14,000 barrels per day, was put in operation a year ago.

The new Ultraformer is one of several large-scale facilities put into operation recently at the Whiting refinery. Among them are:

1. A new 60,000 bpd pipe still, increasing Whiting refining capacity to about 220,000 barrels a day and permitting shutdown of several small crude running units.
2. A modern 6000 bpd lubricating oil plant, replacing obsolete facilities.
3. A modernized alkylation unit, also a large-volume high-octane gasoline manufacturing plant.

Foster Grant Co., Leominster, Mass., has a capital construction program for the next fifteen months that will amount to an estimated $5.4 million. It will include a major addition to the styrene monomer plant at Baton Rouge, La.; additional facilities at the Manchester, N. H., plant and other styrene polymerization facilities at a location yet to be determined.

Foster Grant is primarily engaged in the production of polystyrene and of styrene monomer, and in the manufacture of a variety of molded plastic articles.

Douglas Oil Co. of California has placed on stream a general utility Unifining unit of 1300 bpd capacity at its Bakersfield refinery.

The unit, licensed by Universal Oil Products Co., is designed for several types of operation. In one phase, it will be used to produce high quality kerosine and distillate oils from California crudes. It also will be used as a pretreater to desulfurize naphtha derived from sour Santa Maria crude and for thermal cracked naphtha prior to charging to a 2500 bpd UOP Platforming unit.

Celanese Corp. of America will build a new chemical laboratory, boiler plant, and instrument panel at its Big Spring, Texas, plant. Cost of the entire project will come to about $334,000.

Gulf Oil Corp. is increasing the capacity of its Waddell plant at Crane, Texas. Cost of the expansion program which is to be completed sometime next year, is about $8 million.

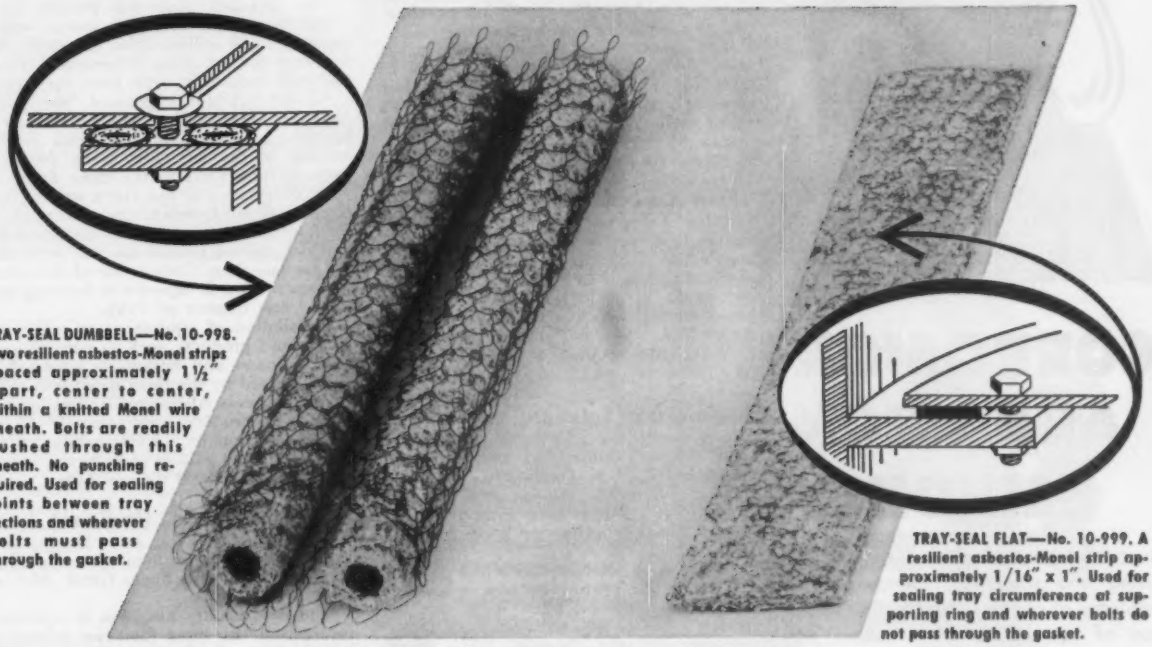
Diamond Alkali Co.'s plans for building an acetylene unit at its Deer Park, Texas, site have been delayed until the selection of an acetylene process has been made.

Petrocarbon Developments, Ltd., England, will design a large scale polystyrene plant to be built in Poland.

Neste Oy has gone on stream with Finland's first refinery, a 17,000 bpd plant located at Tupavuori, near Turku. One point of controversy which has been standing for some time has been settled, and that was who would supply the refinery with its crude oil. It has now been agreed upon that half of the crude will be furnished by Western oil companies, and the other half from the Black Sea under Finland's trade agreements with the Soviet bloc.

Gulf and Shell are supplying 10 percent and 40 percent respectively of Persian Gulf

Now—a better seal against leakage across fractionating trays



TRAY-SEAL DUMBBELL—No. 10-998. Two resilient asbestos-Monel strips spaced approximately 1½" apart, center to center, within a knitted Monel wire sheath. Bolts are readily pushed through this sheath. No punching required. Used for sealing joints between tray sections and wherever bolts must pass through the gasket.

TRAY-SEAL FLAT—No. 10-999. A resilient asbestos-Monel strip approximately 1/16" x 1". Used for sealing tray circumference at supporting ring and wherever bolts do not pass through the gasket.

METEX TRAY-SEAL GASKETING

Pure Asbestos Fiber and Knitted Monel Wire

Proved by more than two years on-stream service in a large East Coast refinery, Metex Tray-Seal Gaskets[2] have cut leakage previously experienced by as much as 84%. Because it contains no cotton, Tray-Seal showed no charring, even at temperatures of 750° F. No replacements were needed at turn-arounds and tightening of a few bolts was the only attention required.

Installed like conventional tapes, these new gaskets have proved more effective than any other gasketing previously used. Bolts between tray sections are readily pushed through the sheath around Tray-Seal Dumbbell—no punching required. Use Tray-Seal Flat around tray circumference and where un-punched gasketing can be used. Tray-Seal can also be furnished on order as formed gaskets for use on risers, caps and where continuous tapes are not practical.

If you are faced with operating and production problems resulting from excessive tray leakage, write for detailed information...no obligation of course.

1. ®International Nickel Co.

2. U.S. Patent #2,761,203 dated September 4, 1956.

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crude under long-term contracts with Neste Oy. The Black Sea crude will come from Soviet Tujmaza.

The plant was originally designed by Lummus Co. to handle both Middle East and Black Sea crude. Now the two crudes are fed mixed in a 50-50 ration. Total cost of the refinery is about $21 million, excluding a $3.9 million Finnish purchase tax on machinery and equipment.

The plant which is now operating at about 90 percent capacity, is expected to meet only about half of Finland's fast growing and changing oil demand. This year's total demand is estimated at 38,000 bpd, a 15 percent increase over 1956. Demand for fuel oils is also growing rapidly.

Union Carbide Corp. is considering building a second major petrochemicals facility in the United Kingdom. The company's subsidiary, Union Carbide, Ltd., is to erect a 45 million pound per year ethylene oxide plant at Fawley, where Esso has a refinery which is to supply ethylene. Union Carbide's 24 million pound per year polyethylene plant at Grangemouth is now complete.

Commercial Solvents and **Columbia Gas System** have called off plans for a joint venture to produce ethylene and other hydrocarbon derivatives. Columbia Gas will, however, go ahead with plans to put $13 million into extraction and fractionation facilities in West Virginia and Kentucky.

Commercial Solvents said it had to withdraw from the venture because it was not economically feasible, and cited the increased costs of construction as a factor entering into the decision. CSC would have contributed technical know-how and marketing organization to the joint venture.

Now, Columbia Gas will go ahead with the portion of development it was going to undertake under the original setup, and is reportedly still shopping for a partner for further development. Columbia has optioned an additional 400 acres next to its fractionation site near Siloam, Ky., for additional plant space to provide for future major petrochemical development. This is the same site that had been optioned for the CSC-Columbia joint venture.

Columbia hopes to have the $8 million extraction plant and the $5 million fractionation plant in operation by late 1958 or early 1959.

Societe des Produits Chimiques D'Aquitiaine is planning to construct a number of plants in southwest France to make acetylene, methanol, and ammonia from natural gas supplies abundant in the area.

Hungarian Government has announced that a new polyethylene plant with a daily capacity of about 200 pounds is nearing completion in that country.

American Cyanamid has broken ground for a multimillion dollar plant on Escambia Bay, 14 miles from Pensacola, Fla., for making Creslan acrulic fiber. Scheduled to go on stream in late 1958, the plant will have a capacity of 27 million pounds per year. It will receive its acrylonitrile raw material from cyanamid's Frontier plant near New Orleans.

Sinclair Oil & Gas Co. has authorized the construction of Gas Products plant No. 29 in Lea County, N. M., to conserve and process oil-well gas from three pools in the West Texas-New Mexico area.

The plant will process gas produced in the Gladiola and North Gladiola pools of Lea County, New Mexico, and the Bronco pool of Lea County, New Mexico, and Yoakum County, Texas. The plant will be located in the Gladiola field, in township 12 south, range 38 east.

The proposed plant will provide for a complete wet gas gathering system with a capacity of 10 million cubic feet daily, and a system for returning dehydrated, desulphurized residue gas for lease operations.

To prepare for expansion, the initial compressor installation will be capable of handling a volume of gas equal to 185 percent of the gas now being produced from existing wells in the three fields.

Sinclair plans to recover a raw unfractionated liquid hydrocarbon mixture at the earliest possible time. The desulphurized and dehydrated residue gas will be available for sale then. Completion of this phase of construction is expected to be completed in the first quarter of 1958.

Installation of equipment to make specific liquid products, such as natural gasoline, propane and butane, is expected to be completed by the third quarter of 1958.

After process equipment is installed, the plant will produce approximately 15,600 gallons of propane, 11,600 gallons of butane, and 8800 gallons of natural gasoline, or a total of 36,000 gallons daily.

Standard Oil Co. (Indiana) is successfully operating a new large-volume high-octane gasoline manufacturing plant on its first run at its Sugar Creek, Mo., refinery.

The new facility has been in operation continuously for more than two months on its initial run. Production capacity is 160,000 gallons a day.

The alkylation unit occupies 38,000 square feet. Its principal fractionating tower is 150 feet tall, 11 feet in diameter, and weighs about 120 tons. It contains 56 specially designed trays for separation of the alkylate product.

Anderson-Pritchard Oil Corp. has completed one final step in an extensive modernization program at its Cyril, Okla., refinery with the startup of a 5000-bpd UOP Fluid Catalytic Cracking Unit.

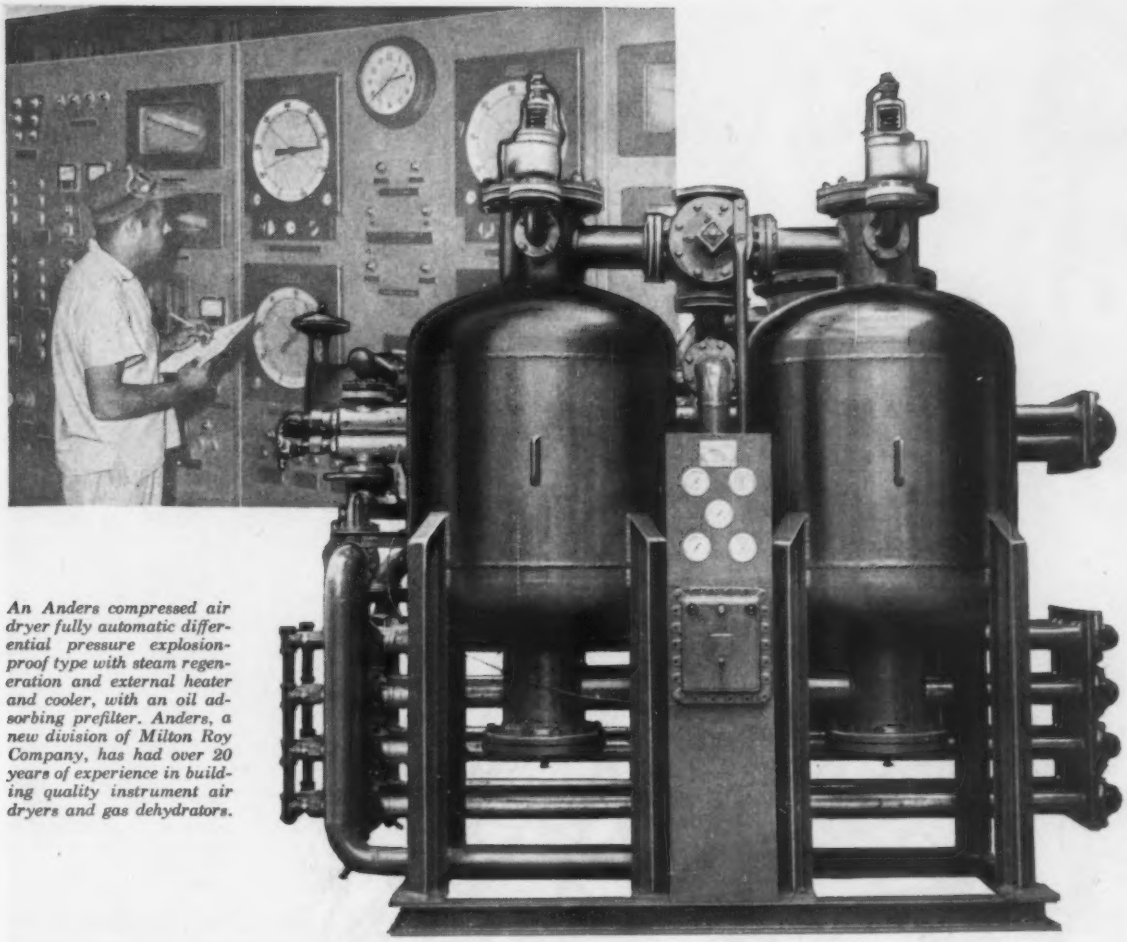
Erection of the cat cracker, new gas concentration facilities and revamping of existing crude, vacuum and polymerization units were handled by Procon, Inc.

At design capacity, the cat cracking unit operates at 75 percent conversion, and has a coke burnnig capacity of 7000 pounds an hour. It is processing atmospheric and vacuum gas oils derived from Oklahoma crude.

Universal Oil Products Co. designed, engineered and licensed the cat cracker.

Suntide Refining Co. has placed on stream at its Corpus Christi refinery an 11,000-bpd UOP Rexforming unit consisting of a UOP Platforming section and a Udex section—one of the largest catalytic reformers built for an independent refiner—and a 6000-bpd Unifining unit. Startup of these units is the forerunner of an unusual operation.

Designed to produce a motor fuel blending component in excess of 100 leaded octane, the Platformer is processing naphthas derived from Gulf Coast crude. The refinery's total straight run gasoline output



An Anders compressed air dryer fully automatic differential pressure explosion-proof type with steam regeneration and external heater and cooler, with an oil adsorbing prefilter. Anders, a new division of Milton Roy Company, has had over 20 years of experience in building quality instrument air dryers and gas dehydrators.

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You can be sure that your pneumatic control instruments will operate at highest efficiency when your air supply is clean and dry. Proper conditioning of your air supply is assured by Anders Instrument Air Dryers . . . continuous units in which the adsorption, reactivation and cooling cycles are entirely automatic, requiring no attention. Semi-automatic and manually regenerated models are also available.

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Anders air dryers range in size from a 5 SCFM to an 11,500 SCFM unit. Specially engineered dehydrators for various gases and liquid hydrocarbons are also available . . . in sizes to 100,000 SCFM, at pressures up to 6,000 psi.

For additional information, write for Bulletin 857—"Anders Instrument Air Dryers."

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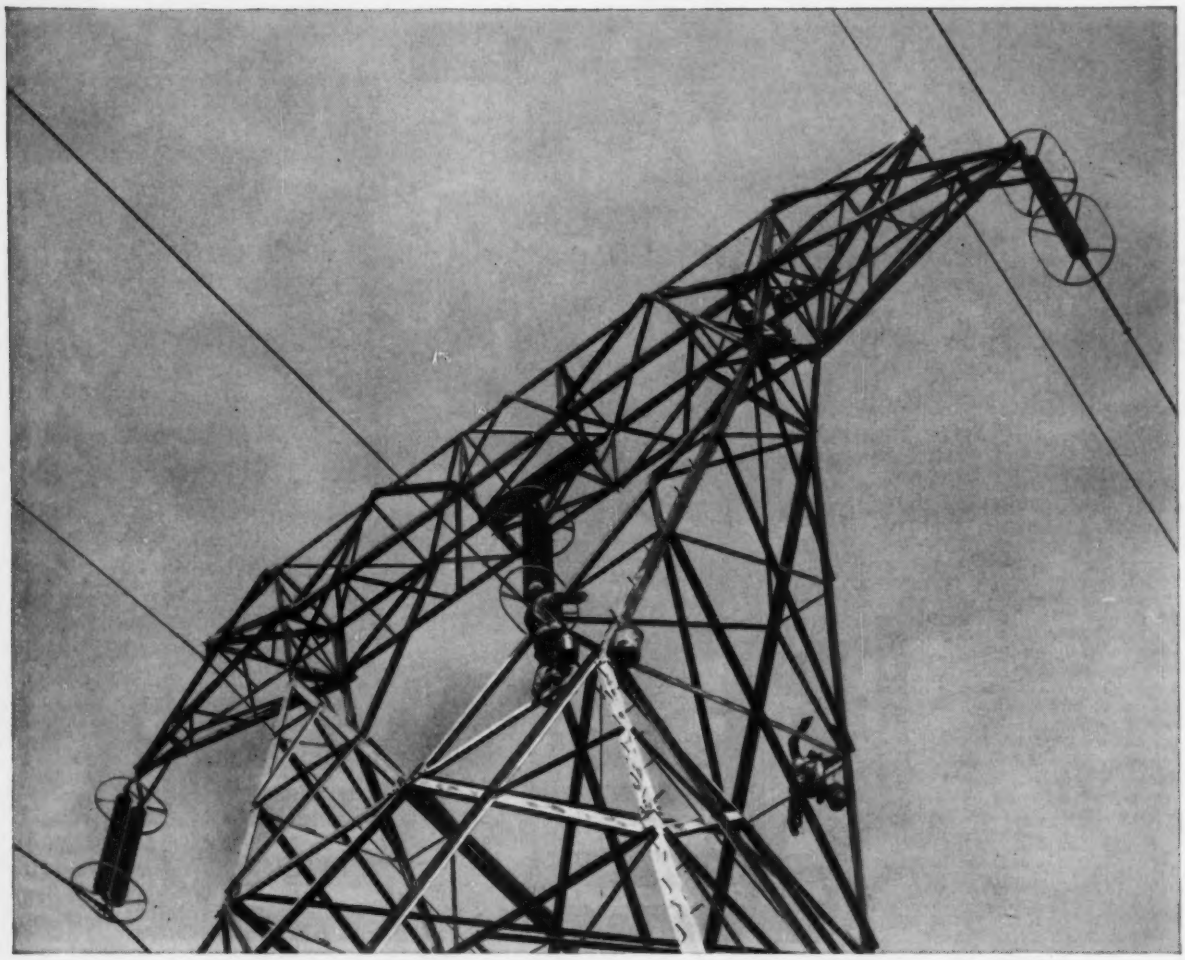

How much does it cost to paint a tower?

That's a difficult question to answer, for much depends upon the size of the tower, and its location. But whatever the figure, it adds up to a major expense when rust-drip from tower bolts makes premature painting necessary.

It's now possible to obtain bolts which resist corrosion even longer than the tower members. These bolts are coated with Bethalume—Bethlehem's new hot-dip aluminum coating. Their cost? Just slightly more than ordinary tower bolts.

The Bethalume coating enables fasteners to resist corrosive atmospheres because it arms the base steel with a durable, uniform layer of aluminum. The coating is applied by the hot-dip process, and in equal thicknesses, outlasts ordinary protective coatings in practically every corrosive atmosphere. What's more, the coated threads are relatively clean and smooth-fitting.

If you would like to know more about Bethalume-coated fasteners, and how they can hold your painting costs to the minimum, just get in touch with the nearest Bethlehem office.

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BETHLEHEM STEEL

Who's Building...

is charged to a prefractionator, which depentanizes the gasoline and produces a light sidecut naphtha and a heavy bottoms naphtha.

The latter is then sent to Unifining. The resulting hydrogen treated material is combined with the light naphtha, this mixture constituting feed to the Platforming section.

With the Udex unit on stream, the Platformer is operated on a blockedout basis. Light naphtha from the prefractionator will be Platformed and fed to the unit when it is desired to produce high purity benzene, toluene, and xylenes. Only Unifined heavy naphtha will be charged to the Platformer when it is being operated to produce motor fuel blending component.

The British American Oil Co., Ltd., refinery at Clarkson has commenced receiving crude oil through the recently completed extension of the Interprovincial Pipe Line.

Extension of the pipe line system from Sarnia coincided with the completion of additional crude processing facilities at B-A's refinery. The new unit adds 40,000-bpd capacity to Clarkson's previous 21,500-bpd. A new catalytic reformer for the production of top quality gasolines was completed at Clarkson earlier this year.

General Petroleum Corp.'s new 12,000 bpd catalytic reformer at its Torrance, Calif., refinery, is almost complete.

The reformer, which is being constructed by the Ralph M. Parsons Co., Los Angeles, is the third to be built at General Petroleum refiineries. The Torrance project is expected to be completed in the fall.

Wilshire Oil Co. of California has placed on stream a combination UOP Platforming-Unifining unit at its Norwalk refinery.

Each unit has a 10,000-bpd capacity. The Unifining unit is pretreating Kuwait and California-derived naphthas for feed to the Platformer, which is designed to produce a 100 leaded octane blending component for use in premium motor fuels. The Platformer has a rerun column, which gives the unit flexibility in producing various premium gasoline blending components.

The combination unit was designed, engineered and licensed by Universal Oil Products Co.

Wainwright Producers & Refiners is considering an expansion program which will double gasoline yield and boost by 80 percent its diesel and distillate yields.

A thermal cracking unit with capacity of 3,000 barrels daily and a platformer with 1000 bpd capacity will be installed along with a polymerization plant, desulphurizer and other equipment.

The company has retained Ralph M. Parsons Co. of Los Angeles to design the equipment required.

Westcoast Transmission Co. has announced plans for construction of a $15 million sulfur extraction plant at Coleman, Alberta, which would be served with wet gas from the Savanna Creek field.

The company has completed contracts to take all of the gas produced from the field by the companies currently operating

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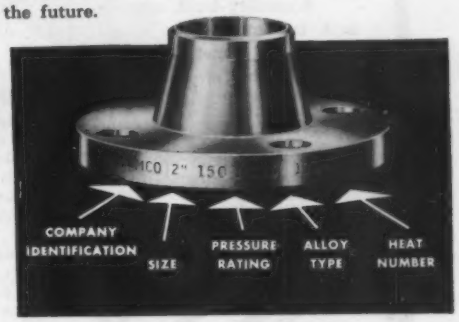

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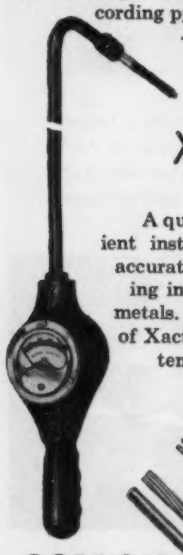
Controls temperature automatically within a fraction of a degree in any heat process. A complete factory-assembled unit ready for installation anywhere. Can be used with any existing indicating or recording pyrometer controller —regardless of age.



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A quality-built, convenient instrument for quick, accurate temperature reading in molten nonferrous metals. Also, other models of Xactemp for all-around temperature checking.

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Who's Building...

it. The proposal ties in with plans of Westcoast to carry Savanna Creek gas to Kingsgate, on the British Columbia-U. S. border, for export to the U. S.

Spencer Chemical Company's new urea plant now under construction at Henderson, Ky., will utilize the Fauser-Montecatini process for urea manufacture.

According to Montecatini, this will be the third American plant to utilize the Fauser-Montecatini process to produce urea. Spencer is already successfully operating a urea plant at Vicksburg, Miss., and Shell Chemical Co. is producing urea by the Fauser-Montecatini process at its plant in Ventura, Calif., the company reports.

The new Spencer facility at Henderson, Ky., is reported to have a capacity of 100 tons per day.

McColl-Frontenac Oil Co., Ltd., has placed on stream a UOP Platforming unit licensed at its Edmonton, Canada, refinery.

The new Platformer, which has a design capacity of 3300-bpd, is processing straight run naphtha derived from Alberta crude. It is designed to produce a 98 leaded octane blending component which is being used to upgrade both regular and premium gasolines.

Universal Oil Products Co., Des Plaines, Ill., designed, engineered and licensed the unit.

Phillips Chemical Co. has begun production at its new 180 million pound per year ethylene plant adjacent to Phillips Petroleum Co.'s refinery and natural gas liquids processing center south of Houston at Sweeny, Texas.

Ethylene produced at Sweeny is used to make Phillips rigid polyethylene at the company's Adams Terminal chemical facilities on the Houston ship channel. The new plant has been constructed so that production can easily be increased to 290 million pounds a year.

The ethylene is transported by pipeline to Phillips' 22 million pound capacity underground storage cavern about 12 miles from Sweeny, from where it is piped 60 miles to the Adams Terminal plant. The ethylene will also be available by pipeline to nearby industrial sites which Phillips is selling to companies seeking natural gas, petroleum feedstocks and chemical intermediates.

The large plant of Celanese Corp. of America, a licensee of Phillips' new polyolefin process, is using Phillips-supplied natural gas and ethylene. National Petro-Chemicals Corp. announced only recently its plans to build a large polyethylene plant, also using Phillips natural gas and ethylene.

In December Phillips will complete an extension of its Gulf Coast ethylene pipeline network to supply chemical industries in the Texas City area.

Sunland Refining Co. has placed on stream a 1000 bpd Universal Oil Products Co. designed Platforming unit. The Platformer is producing a 98 octane number (F-1 plus 3 cc TEL) motor fuel. Fedstock is a 170-384 F. naphtha derived from California crude.

Esso Nederland N. V. announced that agreement has been reached between the Netherlands Government and Standard Oil Company New Jersey on the increase of capacity of the Rotterdam refinery, to be constructed in the Botlek area near Rotterdam, from 40,000 bpd to 90,000 bpd. A substantial portion of the production will be exported.

The field construction and the mechanical engineering have been awarded to Badger-Comprimo N. V. of The Hague. Process design is by Esso Research and Engineering Co., New York, while the engineering and architectural office Ir. J. P. van Bruggen, G. Drexhage, Ir. J. J. Sterkenburg and A. Boden at Rotterdam will act as achitects and advisers for the construction of the administrative building and the workshops.

The construction of the refinery will involve an amount of $45.7 million so that Standard Oil Company (N. J.) will increase its investments in the Netherlands substantially.

Construction will be started in 1958 with completion expected in early 1960.

Standard Oil Co. of California, Western Operations, Inc. has announced a quarter-million-dollar contract for construction of a natural gasoline deisobutanizer at its El Segundo refinery. The new equipment will increase the company's isobutane production by approximately 300 barrels a day.

Construction started September 1 and will be complete December 15. Macco Corp., Paramount, Calif., is the general contractor for the job.

Canadian Oil Companies, Ltd., has placed into operation, Canada's first plant for producing chemically pure benzene, toluene, and xylene from petroleum at its Sarnia, Ontario, refinery.

The three aromatic hydrocarbons are being produced in an integrated UOP Platforming-Udex extraction unit which went on stream recently. The unit completes a $3 million program to expand the company's petrochemical manufacturing facilities.

The Platforming unit has a design capacity of 4400 bpd. It is being operated exclusively to produce charge stock for the Udex facility. The Platformer is the second one in operation at the refinery. The No. 1 unit will continue to produce high octane blending component used in the company's gasolines.

Neighboring chemical plants already have contracted for the total benzene output, and the other aromatic products, toluene and xylene, presently are being used in motor fuels.

Universal Oil Products Co. and Canadian Oil's engineering staff designed the Platforming and Udex units, which also are licensed by UOP.

Maruzen Oil Co., Ltd., Matsuyama, Japan, has placed on stream the sixth of 11 UOP Platforming units licensed to Japanese petroleum refiners.

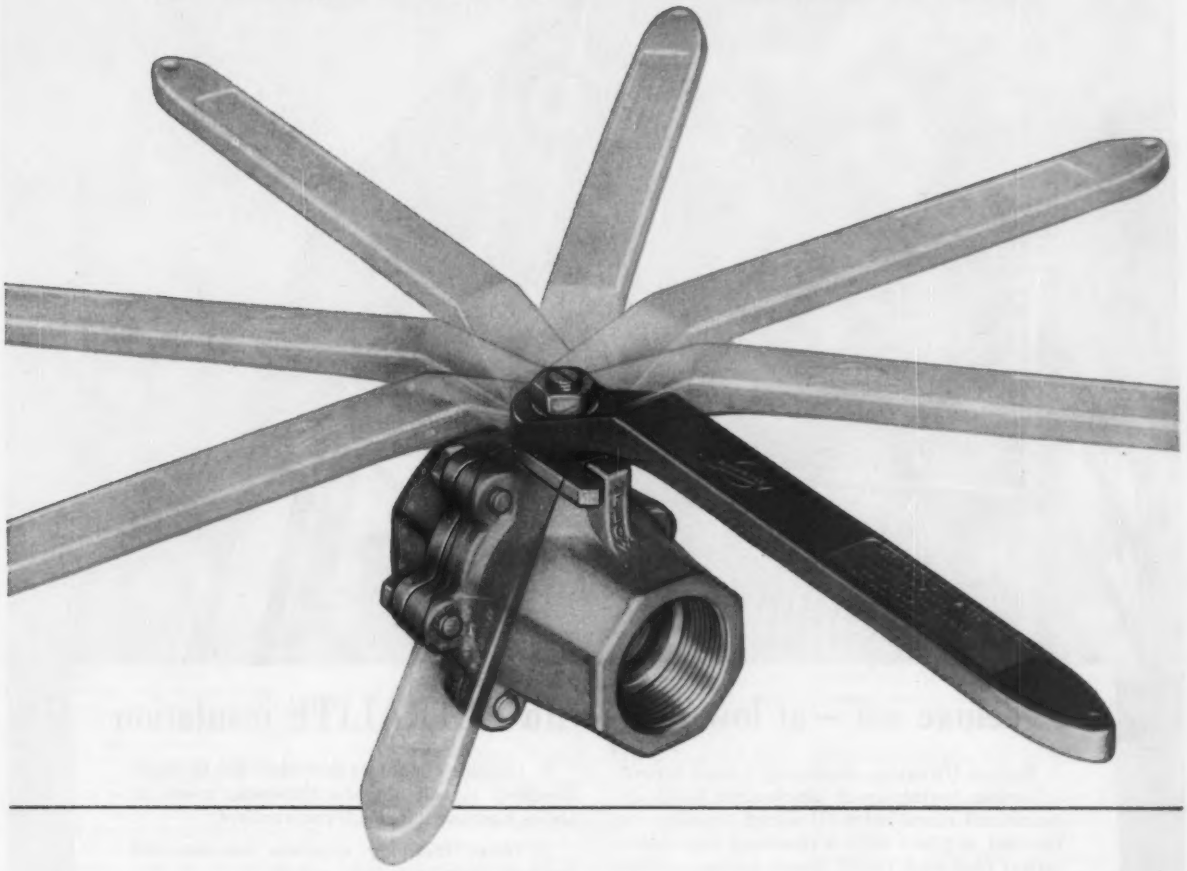
With a design capacity of 3000 bpd the Platformer is designed to produce a 95 F-1 leaded octane blending component from naphtha derived from Middle East crude. Platformate will be used to upgrade the refinery's regular and premium grades of gasoline.

Startup of the Platforming unit marked an important step in an extensive expansion program being carried out at the

For more data on advertised products, use Readers' Service Cards, last page.

New Rockwood Forged Ball Valves

8 Ways Easier to Handle!



New Rockwood Ball Valves are made of forged brass for greater tensile strength and safety. You're assured of Full, Round Flow and fast, efficient operation and less friction loss too.

The handle of the new Rockwood Forged Ball Valve can be positioned in 8 different ways *giving you greater convenience.* The ¼ turn opens and closes the valve — *giving you Full, Round Flow, efficient operation, less friction.* The pressure of fluid in the Rockwood Forged Ball Valve automatically positions the ball against the synthetic rubber seat — *giving you a leakproof seal.* The forged brass ball in the Rockwood Forged Valve is chrome-plated to stand up under abrasion, pitting, scratching — *giving you trouble-free service.*

The new Rockwood Forged Ball Valve comes in pipe sizes from ⅜" to 2". Tested and listed by Underwriters' Laboratories, Inc. Mail the coupon now for complete specifications and information.

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A "deluxe job"—at low cost—with ULTRALITE insulation

Before Ultralite, insulating a tank meant laborious laying up of block after block or batts and more batts all wired together or banded in place with a resulting high insulation cost and many more joints to leak heat. Weatherproofing the completed job with metal made it prohibitively high. But now, Ultralite lowers the cost of insulating so substantially that insulation *plus* metal weatherproofing is a low cost operation; you can have a "deluxe job"—maintenance free, at reasonable cost.

Ultralite saves material handling costs and speeds up application in many ways.

1. Large sections of tank can be insulated at one time with wide continuous blankets of Ultralite, the long glass fiber insulation. In fact Ultralite can be furnished in blanket rolls up to *10 ft. wide* and single thicknesses of *6"*.

2. Ultralite cannot be damaged due to rough handling — will not lose thickness, break or shrink because it is tough and resilient.

3. Fewer fastening members are required because Ultralite is light weight.

4. Ultralite is shipped to the job in compressed rolls — takes up less space.

And, as a "bonus" feature Ultralite offers greater heat savings because of its low K and less joints.

If you are now specifying blocks or batt insulation for heated equipment with troweled finishes or sprayed-on weatherproofing, it will pay you to investigate the advantages of an Ultralite-insulated job—completely and permanently weatherproofed with metal. Write to G-B for detailed specifications.

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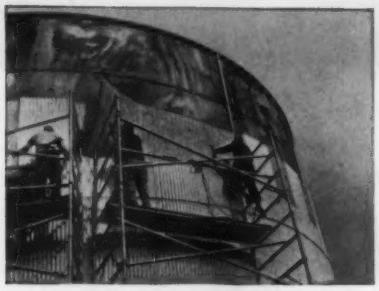

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LOUISVILLE, General Insulation & Roofing Co.
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MIAMI, Southern States Iron Roofing Co.
MILWAUKEE, F. R. Dengel Co.
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NEW HAVEN, Conn., Insulation Supply Co.
NEW ORLEANS, Eagle Asbestos & Packing
NEW YORK, Eastern Steam Specialty Co.
OKLAHOMA CITY, Ball Distributing & Engineering Co.
OMAHA, Cardinal Supply & Mfg. Co.
PHILADELPHIA, John F. Scanlan, Inc.
PITTSBURGH, Dravo Corp.
PHOENIX, Ariz., Kircher Asbestos & Rubber Co.
RALEIGH, N. C., Southern States Iron Roofing Co.
RICHMOND, Va., Southern States Iron Roofing Co.
ROCKFORD, Ill., Mott Brothers Co.
SALT LAKE CITY, Bullough Asbestos Supply Co.
SAN ANTONIO, The Bracken Co.
SAN DIEGO, Western Fibrous Glass Products
SAVANNAH, Ga., Southern States Iron Roofing
SEATTLE, Western Fibrous Glass Products
ST. LOUIS, The Brauer Supply Co.
ST. PAUL, Asbestos Products Co.
SOMERVILLE, Mass., Thermal Insulation Co.
SYRACUSE, N. Y., Industrial Supply Co.
TAMPA, Fla., Eagle Roofing & Art Metal Works, Inc.
TALLAHASSEE, Fla., Bakers, Inc. of Tallahassee
TULSA, Okla., Ball Distributing & Engr. Co.
WASHINGTON. Walter E. Campbell Co., Inc.
WICHITA, General Metals, Inc.
VANCOUVER, B. C., Fleck Brothers Limited

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Who's Building . . .

refinery. In addition to construction of the new facility, the capacity of the crude unit was increased and erection of a 1500 bpd Udex unit was begun.

The Udex unit, one of several to be licensed in the Far East, will be integrated with the Platformer to produce high purity benzene, toluene and xylenes for the rapidly expanding markets for these aromatic hydrocarbons in the Orient. When the Udex unit is on stream, the Platformer will be operated on a blocked-out basis to produce, alternately, motor fuel blending component and Udex charge.

Design and engineering of the Platforming and Udex units was handled by Universal Oil Products Company, Des Plaines, Ill., in conjunction with the Japan Gasoline Company, which licensed the units.

Standard Oil Co. (Indiana) has announced that a new large-volume high-octane gasoline manufacturing plant is operating successfully on its first run at the company's Sugar Creek, Mo., refinery.

The new facility has been in operation night and day for more than two months on its initial run. Production capacity is 160,000 gallons a day.

Employing the latest advances in catalytic alkylation, the unit converts relatively low-value refinery gases into a very high octane gasoline component.

The alkylation unit occupies an area of 38,000 square feet. Its principal fractionating tower is 150 feet tall, 11 feet in diameter, and weighs about 120 tons. It contains 56 specially designed trays for separation of the alkylate product.

The alkylation unit at Sugar Creek is one of seven new processing units Standard Oil has put into operation this year at six refineries in midwestern states.

The Fluor Corp., Ltd., Los Angeles engineering-construction firm, has been awarded a contract of approximately $2 million for the designing, engineering and construction of a 35,000-bpd crude unit for the Utah Oil Refining Co.

The new unit will be built at Salt Lake City, where Fluor recently completed a 5500 bpd Ultraformer for Utah Oil Refining Co.

Construction is scheduled to begin late this year with completion set for mid-1958.

E. I. du Pont de Nemours & Co., Wilmington, Del., is designing a plant to produce linear polyethylene resins on the Mississippi River 32 miles upstream from New Orleans.

Robert L. Hershey, general manager of the company's polychemicals department, said that engineers are drawing up plans and cost estimates for a plant on a 600 acre site just west of Laplace, La., which was purchased last winter. Final decision on building the plant will await the outcome of these studies, Hershey said.

Two years ago the company announced that it had acquired a license to use a catalyst developed by Dr. Karl Ziegler, of Mulheim-Ruhr, Germany, for the manufacture of linear polyethylene. While this agreement makes it possible for duPont to use this catalyst, Hershey said he could not announce as yet whether it would be employed in the contemplated commercial plant.

Stanford Research Institute has established a new $50,000 plastics laboratory to accommodate the applied-research center's expanding plastics research program, according to Dr. Donald L. Benedict, chairman of the Physical Sciences division.

The Institute has been actively engaged in plastics research work since 1950. During the 7-year period, the staff has built up a reservoir of knowledge and capabilities in the field of polymer chemistry. The dollar volume of contract research has climbed commensurately. For the calendar year of 1957 this work will reach $250,000.

The new laboratory provides a centralized facility which houses over $40,000 in equipment. A group of 32 scientists and technicians is engaged in the plastics research program.

Major areas of plastics research at SRI include the synthesis and evaluation of new polymers; study of the effects of high-energy radiation on polymers and the synthesis of polymers amenable to improvement by radiation, and the lamination of plastic films to polyester glass laminates.

Typical recent problems include the formulation and evaluation of polyolefins specifically designed for radiation cross-linking, the casting of polyester glass laminates, and the study of the stability under radiation of adhesives used in assembling nuclear-powered aircraft.

Stauffer Chemical Co. will build a 400-ton-per-day capacity sulfuric acid regeneration plant at Hammond, Ind., which will process oil refinery sludge acids. Construction of the new plant will begin at once and full scale production is scheduled to begin next July.

It is estimated that Stauffer's investment in the new facility will be in excess of $4,000,000. It will relieve oil refiners of the perplexing sludge disposal problems with which they formerly had to cope.

Guatemala may get its first refinery in the form of a 2000 bpd plant that may be dismantled and shipped from Louisiana.

Breaux Bridge Oil Refining Co., has applied for a license to transfer its refining installations from Breaux Bridge, La., to Santo Tomas, a port on Guatemala's east coast.

Venezuelan crude will be used by the plant which would produce from 87 to 95 octane gasolines, kerosine, bunker "C" fuel oil and LPG.

Grebe & Doremus Process Co., Houston, will furnish the technical design and know-how for the installation.

Union Carbide Corporation, New York, has authorized a new plant for Bakelite polyethylene resins at Whiting, Ind.

The new high-pressure polyethylene plant, with a rated annual capacity of 72 million pounds, will raise Union Carbide's total rated annual production capacity to more than 375 million. The new Whiting plant raises the total of Union Carbide plants involved in the production and compounding of Bakelite polyethylene resins to nine.

As in the case of Union Carbide's other polyethylene plants, this one will be built and operated by Union Carbide Chemicals Co., with sales and technical services supplied by Bakelite Co., both divisions of Union Carbide.

For more data on advertised products, use Readers' Service Cards, last page.

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These heaters have proven highly beneficial in numerous critical applications, including:

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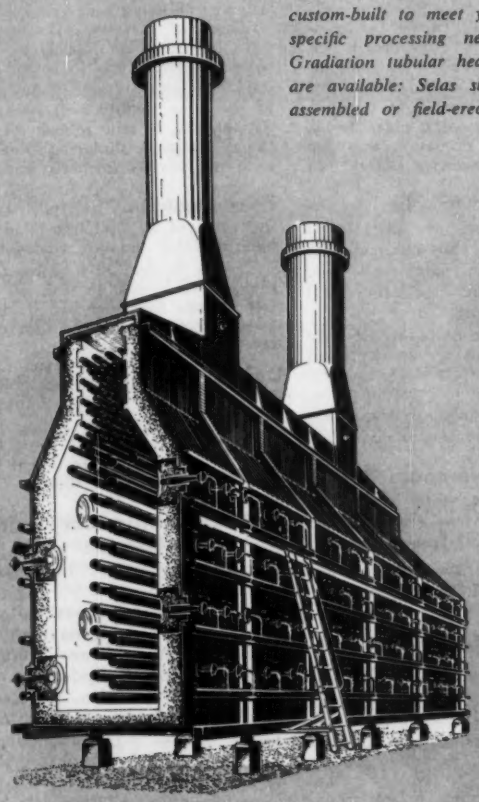
Specially-engineered and custom-built to meet your specific processing needs, Gradiation tubular heaters are available: Selas shop-assembled or field-erected.



NOW

SELAS ANNOUNCES ECONOTHERM*

a new family of TUBULAR HEATERS

For many good reasons, chief of which is the demand for heaters to accomplish non-critical processing, Selas Corporation of America has created a new family of tubular heaters to be known as Selas Econotherm Tubular Heaters.

Econotherm Heaters are being used where operations require materials to be heated to below decomposition temperatures; where, because of this condition, precise control is not essential; where—because of the nature of the operation—low cost is an important factor.

Actually, Econotherm Heaters are not new to Selas or to its customers. Previously furnished as custom-built units to meet specific non-critical requirements, basic Econotherm designs have now been developed to achieve maximum economy. Three representative configurations, together with their processing capacities, are shown on the facing page.

And, to meet processing conditions not covered by these standard units, specially-designed Econotherm Heaters will continue to be custom-built as required.

Unlike Selas Gradiation Heaters which use Duradiant® burners to accomplish their preciseness of heating in critical processing, Econotherm Heaters employ flame-type burners and can accommodate gas, oil or combination firing.

The addition of this new family to Selas' Fluid Processing Division serving the petroleum, petrochemical and chemical industries, rounds out the line of heaters so that processors may call upon Selas for every heat-processing need.

Write Dept. 1410 for bulletin "Gradiation Heating for Petroleum and Chemical Processing" and for more detailed information about Selas Econotherm Heaters.

*Trade Name

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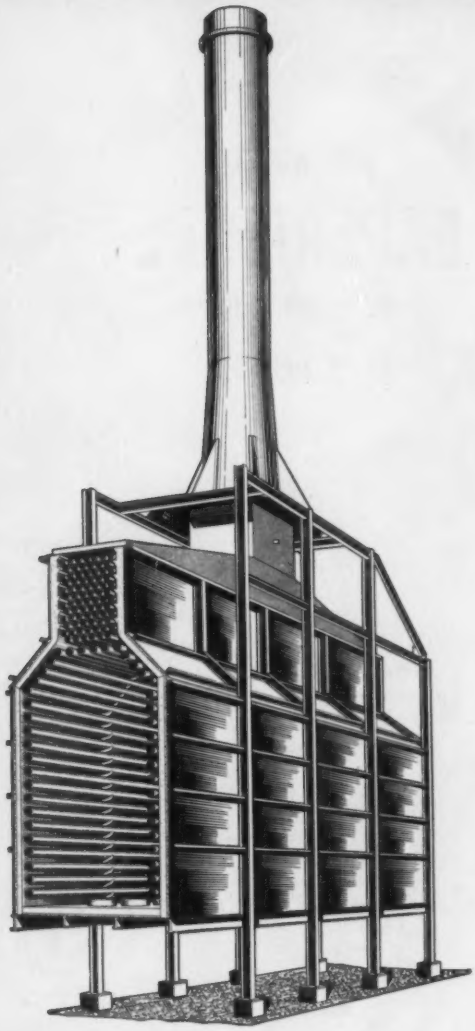
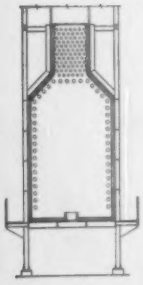
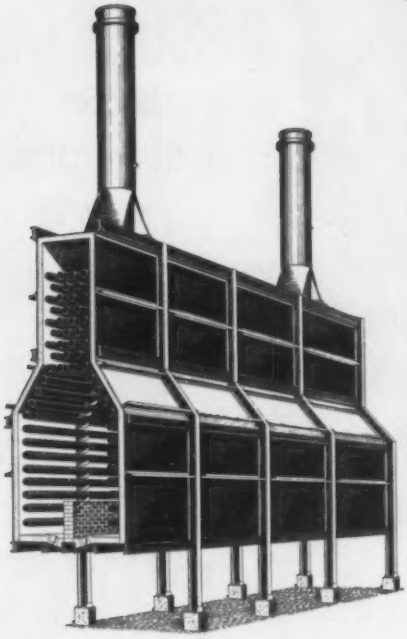
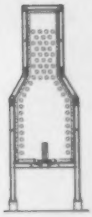


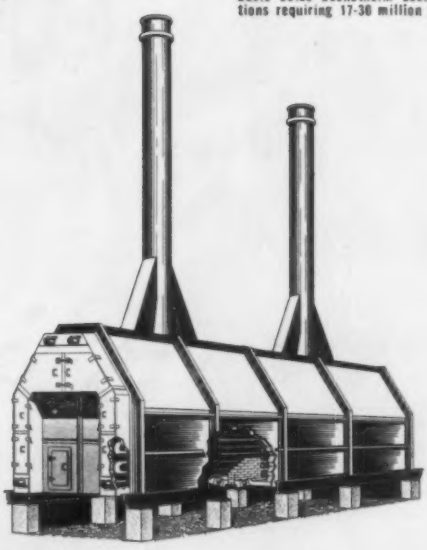


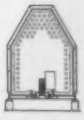
Basic Selas Econotherm design for processes requiring more than 30 million Btu per hour.





Basic Selas Econotherm design for operations requiring 17-30 million Btu per hour.





Basic Selas Econotherm design for processing requirements from 8-17 million Btu per hour. A basic design is also available for requirements up to 8 million Btu.

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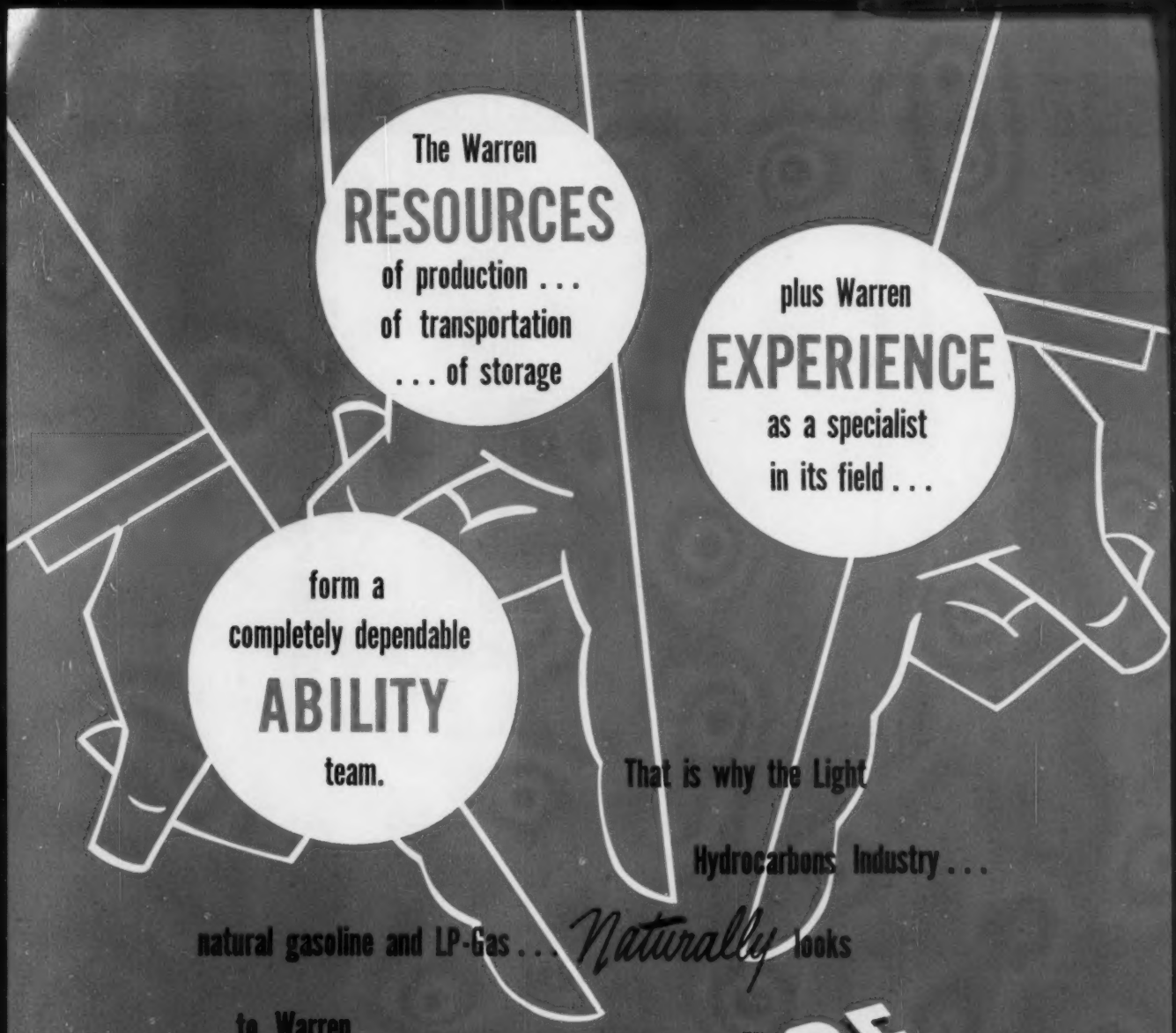

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As Management Sees It . . .

ABC's of Better Writing

Use these four rules of thumb. They are tailor-made to help you write clearer, more concise technical articles and reports.

By John L. Kent
Consolidated Electrodynamics Corporation, Pasadena, Calif.

EDITORS COMPLAIN that engineers don't know how to write for their readers. Research directors and other company administrators complain that their engineers write poor reports.

Yet, technical writing can be improved easily. Special courses at industrial firms and in government laboratories have proved that.

The engineer's inability is chiefly due to a lack of knowledge. Unfortunately, this knowledge is not readily available. Refresher courses are few, and the several textbooks are long on theory and short on practical help.

Engineers' training and experience help them become good writers faster, but at the same time throw a number of hazards in their paths.

First of all, because they are used to doing things systematically, engineers do not have too much trouble organizing their written presentation. On the other hand, because they are detailists, they often include all the details, failing to weigh their relative importance for the purpose of the report or article.

Engineers deal with facts and things. They therefore find it easy to write their reports and articles unemotionally and without bias. But because of this objectivity, they also find it difficult to engage in the "light touch" that is often necessary to explain difficult passages.

Learn the "Professional" Touch. Generally, the engineer-writer succeeds almost directly in proportion to his adoption of methods used by professional writers.

The professional writer—the man who earns his bread by his writing skill—must have somehow acquired techniques which serve his purpose. And, of course, he has. These methods are adaptable to technical writing. They can be summed up under four headings:

1. Plan and outline.
2. Consider the reader.
3. Use short sentences and simple words.
4. Be critical.

Planning Is the First Key. The first, and most important key is proper planning. Whether it's an article, report or other technical manuscript, an outline and a period of planning are necessary. Write an outline.

Every type of writing has its own outline—its writing format.

A report, for example, is a specialized form of expository writing whose order should be apparent through section headings, sub-headings, numbered paragraphs and other means.

An article, too, has a form. It is not a cutdown report. It's a distinct piece of writing.

A technical article does not have to be as complete and as detailed as a report. You can omit details of minor importance. This "selective omission" is one of the major differences between the report and the article. A technical article will have a more general audience which will include many "non-specialists." This means that you will have to broaden your appeals somewhat.

The detailed planning should not be hurried. Professional writers point out that after making an outline, the writer should temporarily forget about

Checklist for Technical Reports

Experienced writers have learned that they could find errors and flaws in their writing and presentation only by using a checklist and systematically going through their manuscript several times. Here is one for checking reports.

1. First consider the report as a whole
- a. Are the various parts labeled properly?
- b. Is there evidence of orderly presentation?
- c. Does report tell a story?

2. Introduction
- a. Does introduction agree with other parts of report?
- b. Have you told reader what you will tell him in report?

3. Body of report
- a. Have you described methods or operations completely?
- b. Are details clear enough so another person can reproduce work?

4. Check conclusions and recommendations
- a. Do they answer the problem posed in introduction?
- b. Are recommendations clear? Do they avoid hedging?

5. Composition
- a. Have you clearly marked transitions from one topic to another?
- b. Check paragraphing.
- c. Check sentence structure.
- d. Check words. Strike out and substitute better ones where needed.

6. Grammar
- a. Look for split verbs, poorly placed adverbs.
- b. Check "and" and substitute better conjunction where possible.

7. Read report again
- a. Are there any weak spots which are not clear?
- b. Consider the reader. Will he understand everything you said?

"The detailed planning should not be hurried."

"Who is your typical reader?"

"Be critical."

the writing and go on to something else. It is important that you do not write the report or article after your mind is apparently primed for it.

A lapse of even a few hours will help produce better written work. During this unproductive time, your subconscious will be working on the article or report. Finally, when you sit down to write, you will find it much easier than you anticipated.

Consider the Reader. The second key to technical writing improvement is to consider the reader. To write well, you must consider your typical reader and write for him.

Who is your typical reader? It is probably another engineer or some technically trained person. This type of person possesses certain characteristics.

First of all, he is a serious person who is reading your material solely to get information. He is not interested in being entertained. A trade journal editor knows this, so in an article you submit he cuts any cute openings or obscure analogies you might have dreamed up.

Because of his education and experience, the technical reader is orderly and neat. He thinks more logically than most of us. Thus he wants to see some semblance of order in your presentation. You can please him by stating your information in some logical manner—chronological, for example. Or, proceeding from the general to the particular. In a report this order is apparent through use of section and subsection headings.

Lastly, your reader is a busy man. In most industrial fields the engineer is pacing progress. So you must use the least amount of his time to tell your story. The editor knows this too, and he acts accordingly. If you haven't taken the engineer's time into consideration, he will. And your story will be cut.

So these are the things you must do:

1. Write for a specific audience—Unless you keep your typical reader in mind as you write, you will not write at the proper level. In engineering writing the tendency is to assume a greater stock of knowledge than the typical reader possesses.

2. Give reader information — He wants to read solely for information. Not for entertainment. Not to kill time.

3. Tell your story quickly — Give him summary-type reports. Write articles with newspaper-style leads. Don't dramatize — summarize. Don't expand—condense.

4. Make your story easy to read—Two easy ways of making your story easy to read: Use short words. Use short sentences.

5. Be clear, concise—Clear writing can be obtained chiefly through simplicity and precision. Keep thoughts (and resulting sentences) simple. Conciseness can be obtained by planning and outlining and by the use of simple grammatical construction.

6. See it from reader's viewpoint—Who cares what you think! It's your reader, not you, who is important. Look at your story from his self-interest.

Use Short Sentences. One of the major "tricks of the trade" of the professional writer is his use of short sentences. The professional writer also uses the short word in preference to the long one.

The short sentence is probably the greatest help to understandable writing. It permits spacing of ideas.

As sentences become longer, relationships between words become less clear. Such sentences are harder to understand and may require rereading. They often lead to errors in grammar.

There's another reason why technical people in particular should write short sentences. In ordinary writing, shorter words can be substituted to help the reader understand. Generally, technical words cannot be simplified. Short sentences can compensate for this limitation.

When average length of sentences runs over 20 words, thoughts become difficult to understand.

A sentence of over 25 words generally can be put into two short ones. After several long sentences, insert a short one to act as a "rest" for the reader's mind.

Be Critical. Being critical of our writing is the fourth key to good presentation. This involves more than a mere reading over and insertion of a comma or the substitution of a better word. It should be a systematic check of the manuscript.

After you have written your first draft, read it over several times to get the feel of it. Are you telling a story? Simply? Concisely?

Read it over again, with a good

dictionary at hand, and look for bad sentences, lack of topic sentences and errors in grammar. If time permits put the manuscript out of sight for a day or two. Then read it over again before letting it out of your hands as finished writing.

Examinations of engineers' writing reveals several failings which are repeated over and over. These include failure to paragraph, use of jargon and cliches, wordiness, and lack of "sell."

The first sentence of a good paragraph should be the topic sentence. It should tell the reader what's going to be said in the paragraph. It should also provide a transition (if such is needed) from the preceding paragraph. This topic sentence should be short and direct.

You Must "Sell" Your Story. The lack of "sell"—the ability to "put over" a story — is evident in both articles and reports. Many articles in trade journals are uninspired and uninspiring.

To get good presentation you must not only get facts down briefly, but so arrange them that the reader can sense that back of the arrangement and presentation was an engineer who knew what he was talking about.

Directness, simplicity and enthusiasm help put over articles, reports and bulletins. People respect a man who knows where he is going. This is also true for a piece of writing.

About the Author

John L. Kent is chief of the Editorial Bureau of Consolidated Electrodynamics Corporation, Pasadena, Calif. During his career he has been a government information officer, trade journal editor, and company periodical and manual writer and editor.

Kent is president of the Technical Writing Improvement Society, and is a member of the American Association for the Advancement of Science, and other professional groups.

As Management Sees It . . .

What It Takes To Be an Executive

"The traits which make a man a good engineer militate against his success as an executive."

Major B. Foster
Alexander Hamilton Institute, New York City

TODAY, MANY companies, faced with the generally increasing average age and approaching retirement of executive personnel, are screening their technically trained people for men who can soon be called upon to assume managerial responsibility.

Many ambitious young men ask, "What kind of an executive does an engineer make?" The question defies an easy answer because there are so many factors which have a bearing on the success of the engineer who goes into management.

We are now going through an almost unprecedented period of change. Automation in the plant, electronic computations, growth and diversification, new products of inventive genius and on the horizon the tremendous potential of peacetime atomic power have all produced technological change of a nature inconceivable a few short decades ago. The engineer has played a major part in this development, and his efforts thus far have not gone entirely unrewarded.

Indeed, for the new engineer, this is the golden age, as starting salaries shoot skyward as a result of the inexorable forces of supply and demand. Trained recruiters comb the college campuses for promising young engineers. Polite raiding is engaged in as firms try to lure engineers into their folds. Full page ads exhort engineers to seek opportunity at such and such a company where working and living conditions are described as a veritable paradise.

But not all engineers are happy with their lot. The gap between starting salaries and those paid men with ten years service is rapidly narrowing. True, good engineers can usually improve their lot by responding to the siren call of other companies, but selling a home, moving expenses, breaking friendships and uprooting the family, often deter engineers from taking this course to more money.

There is another route to more money, however, and happily it is one which is satisfying to both engineer and company alike. This route leads into management. It is no easy road but the rewards are great for those willing and able to follow it.

Engineers can make excellent executives. In fact, engineers are needed in management. But, what kind of an executive an engineer will make depends upon what he does to make himself management material.

More Engineers in Management. The influence engineers exert in management councils is continually rising. One major company reports that 25 years ago only one of their top management personnel was trained in engineering. Today this same company reports that 60 percent of its top executives came from the ranks of engineers. This trend is growing and will continue to grow so long as the engineer continues to make a successful transition into management.

If the engineer fails to broaden his outlook, to become well rounded in his thinking, he will fail; and his management will fail. It is not only industry's solemn responsibility to see to it that he does not fail, but it is his own obligation to prepare himself for future responsibility.

No one can "order" a man to be successful. No one can create a manager out of an engineer who is unwilling to learn. The engineer who goes into management must have the desire to learn and the willingness to pay the price of success.

Where Engineers Fail. Many engineers have become managers, and many of these have been failures. Some of the very traits which make

a man a good engineer militate against his success as an executive. For example, engineers by training are prone to place greatest values on things that can be quantitatively measured. They take an analytical approach to their problems which does not give sufficient weight to certain things that cannot be measured. They neglect things which cannot be solved by logic alone.

But, the very core of business relationships depends upon such things as emotions, human relations, attitudes, traditions, prejudices and the like. In dealing with these things that cannot be measured the engineer is frequently unprepared.

John L. McCaffrey, Chairman of the Board of International Harvester Co. once said:

"The world of the specialist is a narrow one, and it tends to produce narrow human beings. The specialist usually does not see over-all effects on the business. And so he tends to judge good and evil, right and wrong, by the sole standard of his own specialty . . . This narrowness of view, this judgment of all events by the peculiar standards of his own specialty, is the curse of the specialist from the standpoint of top management consideration for advancement. Except in unusual cases, it tends to put a road block ahead of him after he reaches a certain level."

Needed: Human Relations-Reminded Engineers. The management level demands of a man the ability to work as a member of a team. The engineer who goes into management can no longer withdraw into his cocoon and study the problem at hand as if it were in a vacuum. He can no longer be a "loner" as his classroom and early job training has often taught him to be. He cannot study his problem with the time consuming thoroughness to which he is accustomed, because management demands decisions, and the manager must balance the importance of accuracy of decision against the penalties for indecision and delay.

In this big complicated world of business the engineer has much to learn. As a manager he will no longer deal mainly with other engineers. His duties will bring him in contact with accountants and buyers, salesmen and credit men, officers and clerks. A whole new and strange world of business terms and language will confront him. He'll have to gain confidences and be understanding, learn and instruct, be sympathetic, paternal or commanding as circumstances require —and all in the midst of a business organization about which his knowledge is narrowly limited.

Preparing the engineer to go into management is one of the most challenging and important jobs confronting industry today. However, the individual engineer must not take the attitude that he can stand still and wait for the company to do what is best for him. Every company expects qualified individuals who are anxious to make substantial progress to take some steps to help themselves.

What the Engineer Can Do. Companies often make available to their people various books and business literature. They frequently arrange to have visiting authorities on certain phases of business conduct seminars or workshops within the company. Many companies have an educational plan whereby the individual can be reimbursed for all or part of the costs of courses which he takes to make him a more effective employe.

But, make no mistake about it, the top rewards go to those men who take the initiative in their own development.

What can and should the engineer do to prepare himself for management? First, he must reorient his thinking. He should think of himself as a manager with engineering training rather than as an engineer in a management job. This reorientation of thinking cannot be accomplished overnight but it must be done since other steps in management development will fail unless the groundwork has been properly laid.

One way the engineer can help change his thinking from that of the engineer to that of manager is to broaden his interests. He should welcome contacts with people outside his own department, talk to salesmen, buyers, accountants and other people —listen to their problems — try to understand them. He should read business literature as well as matter on his own specialty. At home he should throw in some cultural material. Above all he should take a real interest in human relations—get to know the people he works with and listen to their very human problems.

Another thing the engineer should do is to accept responsibility eagerly. In fact, he should seek it out because many companies believe that their leaders come from men who take risks and are willing to make sacrifices. Responsibility carries risks and men who are reluctant to "stick their necks out" are usually not thought of as leaders.

Engineers going into management should have their say in meetings, being willing to take the chance of being found wrong. They should be willing to state their positions on a subject and support their positions when they are challenged.

While no value comes from stubborn adherence to a belief already proved wrong by experience, management does not want in its ranks the "yes men" so common in our fictional literature. It asks only that a man carry out loyally the decision that is finally reached.

Fundamentals, Decisions and Goals. The engineer preparing for management should organize his knowledge of business. Even the engineer, if he were asked to make a written inventory of his business knowledge, would probably leave out about half of what he does know simply because his knowledge is not organized. Studying business fundamentals will, at the very least, enable the engineer to find out what he does know and enable him better to apply that knowledge to his business problems.

Engineers must learn the art of making decisions quickly without prolonged investigation into every aspect of the question. In management, an immediate decision is frequently of more value than one painstakingly reached after several weeks of consideration. Of course, the ability to make prompt decisions is directly related to confidence, which, in turn, is based upon knowledge and experience. A fundamental knowledge of all phases of business operation is essential to successful executive decision making.

Another qualification for engineers who want to become managers is that they must identify themselves with the aims and goals of their organizations. If a management man does not

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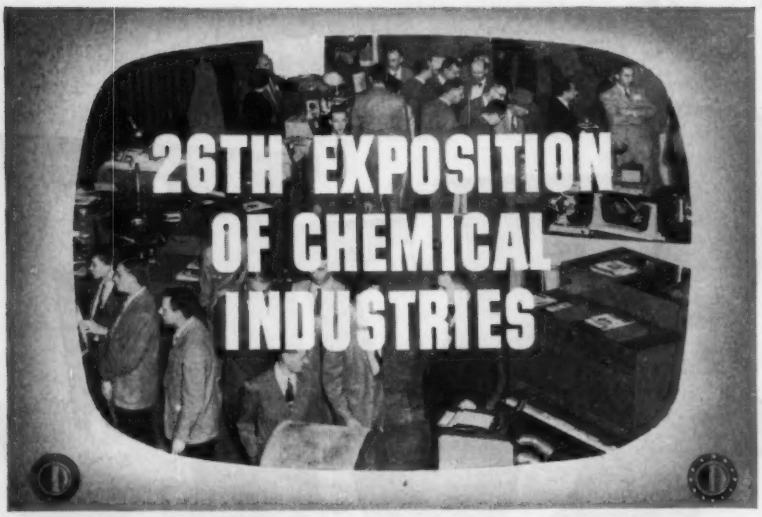

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derive a great deal of satisfaction from his company's growth and development, he can never be a successful manager. Ambition to forge ahead personally in business must be tempered by a real desire to promote the best interests of the organization.

The Time To Start Is Now. In management, it is never too late to learn. The personnel manager of one of our largest companies recently told me that his company had enrolled a 64-year-old manager in a management development course despite the fact he was due to retire in eight months. If companies believe further education is valuable at any stage of a man's life, certainly the individual should, since he is the one who stands to benefit most.

The above recommendations for engineers who are preparing to go into management do not cover the entire field. But they can serve as guideposts to success in management. This year many thousands of engineers will begin the transition into managers. In future years, there is no doubt that an increasing number of top management people will be drawn from the engineering ranks.

Many engineers will make the transition successfully. Others will fail. Those who succeed will be engineers who are willing to put forth some of their own time and effort to develop their managerial talents.

About the Author

Major Bronson Foster graduated from Carlson-Newman College in 1911, then in 1913 he became an instructor in economics and assistant to the dean in the School of Commerce, New York University. From 1918 to 1919, he served as assistant to the chairman of the board of directors of the Federal Reserve Bank of New York, and in 1920 became an administrative officer of Alexander Hamilton Institute. In 1923, Foster became professor of banking and finance, as well as chairman of his department at New York University. In 1935 he was elected president of Alexander Hamilton Institute.

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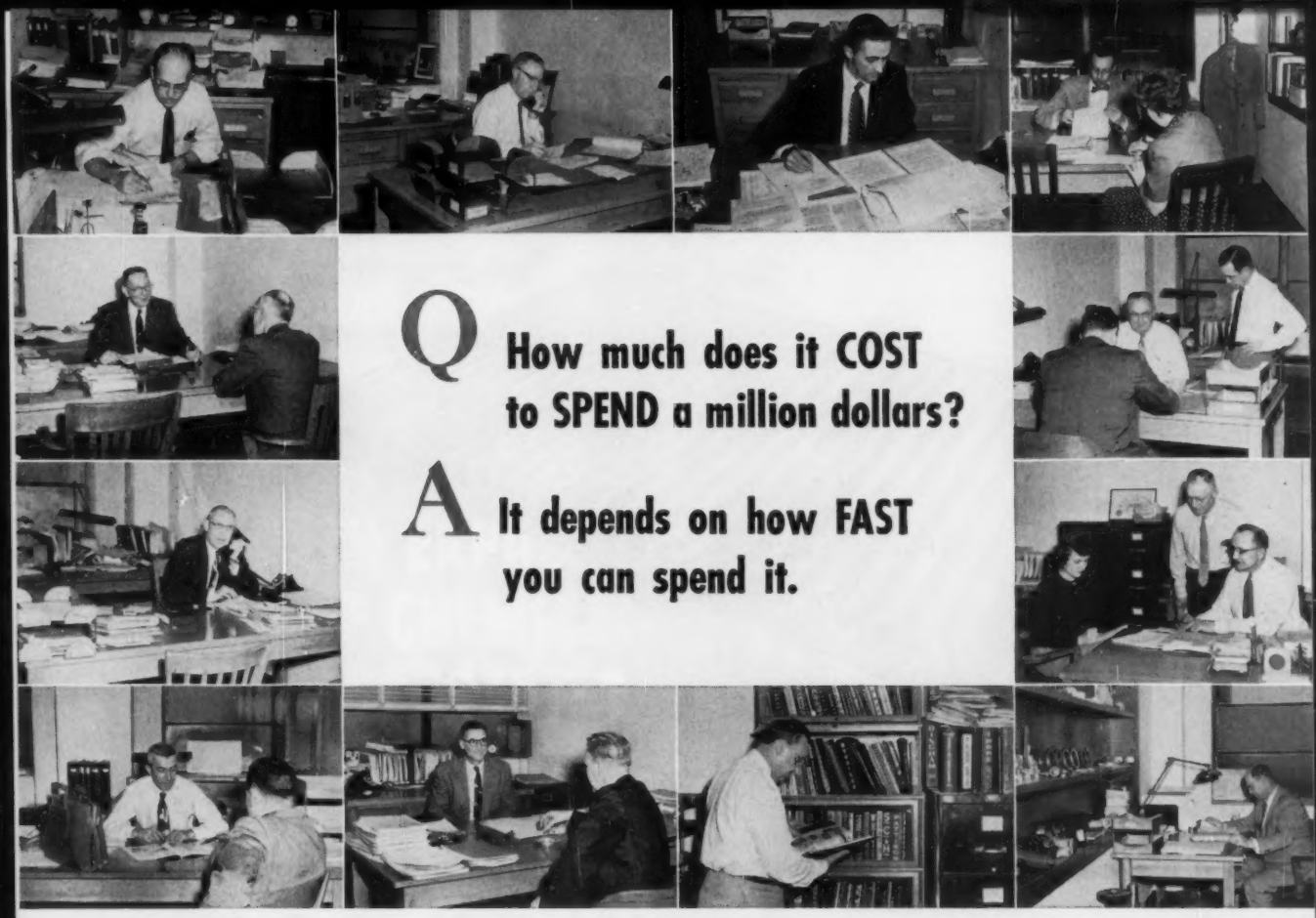

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What You Should Know About Fires

Here are the basics of extinguishing fires as outlined by one of the nation's top authorities.

J. L. Risinger
Consultant
Maplewood, N. J.

THE EFFICIENT fire fighting leader cannot wait until a fire occurs, then go to the library and do research on the particular substance that is on fire. He must know in advance about the burning characteristics of the various substances and structures within his jurisdiction.

By the same token, those who will fight the fires must be trained to act in accordance with what is burning, even to a breakdown of the characteristics of oils involved. Fires that could occur should be fought in practice before they do occur.

Everyone involved in fire fighting should realize that as a general principle each petroleum product is manufactured or selected for a specific purpose or group of purposes. It burns in a manner and under designed specifications and conditions to accomplish its purpose or purposes. When these specifications and conditions are met in each case, fire will occur whether desired or not.

To prevent fire involving a specific product, these specifications and conditions must not be allowed to occur. To extinguish the fire after it has occurred it is necessary to break up the specifications or conditions under which the particular product is designed to burn.

FIGURE 1—The contained oil fire shown above is the simplest fire to control. It is described as a fire in which the oil is at rest in a reservoir, i.e., a tank, pit or pool.

In short, there is no such thing as using one set method to fight oil fires. To use such an approach is not only incorrect, it is extremely hazardous.

Cases have been known where considerable sums of money were spent in the purchase of extinguishers that were entirely unsuited to the extinguishment of the fire involving the property to be protected. One example is the use of CO_2 in woodworking shops where no oil or electric equipment is located. Likewise, oil fire fighting equipment has been purchased after a high flash point fire demonstration proved it effective on this type of oil. It was then placed for extinguishment of low flash point oil. In some cases the equipment was unsuited to extinguishment and in others its capacity of extinguishing the low flash point oil fire was only one third that of extinguishing the high flash point oil.

Situations such as these would seldom arise if everyone involved had a thorough knowledge of the basics of fire extinguishment.

BASICS OF FIRE EXTINGUISHMENT

Know the Flammable Range. The characteristics of ignition and burning of any material establishes the basics of the extinguishment of a fire in which the material or substance is involved. There is no way of counteracting the momentary steps of combustion. To extinguish the fire you simply stop the correct mixture of vapor and air from forming or from getting near enough to the flames to continue momentary flame production—in other words, feed the flames.

As a general rule, the easier the oil will produce the vapor and form the mixture, the more is required to stop this mixing within the flammable range and thus extin-

FIGURE 2—These fire fighters are having little success trying to extinguish a gasoline fire with water fog. Water in any form will not cool gasoline to its minus 45 F. temperature, and thus reduce the vapor formation enough to extinguish the fire. Water fog can be made to extinguish a gasoline fire only if the fog is so concentrated as to expel the air to below 94 percent of the vapor-air mixture.

guish the fire. The more temperature that is required to cause the oil to build a vapor pressure within the flammable range the easier it is to throw the mixture out of the flammable range. The vapor pressure of the oil also serves as a guide in indicating which fires can be extinguished by cooling to reduce vapor formation to below the requirement, and which fires can be best extinguished by the reduction of air in the vapor air mixture to below that required.

It is necessary to consider flammable range produced by an oil in terms of a closed space in which diffusion has produced a mixture of uniform composition. It is emphasized that this composition in the general run of petroleum liquid products is from approximately 1 to 6 volumes percentage vapor and from 99 to 94 volumes percentage air. Also, that in the case of petroleum hydrocarbon gases the flammable range varies, but the maximum range is from 1.9 to 9.5 volumes percentage vapors and from 98.1 to 90.5 volumes percentage air.

Determine Status of the Oil. Classification of petroleum product fires must also take into consideration the status of the specific oil involved. This classifies oil fires as contained and uncontained fires.

The contained oil fire is the simplest fire to control. It is described as a fire in which the oil is at rest in a reservoir, such as a tank, pit, or pool. The fire is said to be trapped. (See Figure 1).

The uncontained fire is a fire in which the oil is flowing and spilling, or is being projected or is dropping from an elevation. The latter is often referred to as a three-dimensional fire.

As the flames are the manifestations of combustion that is momentary, the flames and combustion will starve immediately if they are not fed. So all fires are really extinguished by starving.

The flame itself can not be extinguished. The only way to stop it is to unbalance the burning mixture that is feeding the process of combustion that produces it. This can be done by removing the source of vapors such as cutting off the flow of liquid to the fire, or by reducing the volume percentage of vapor below that required.

In some substances the body itself can be cooled easily to sufficiently obtain the required reduction of vapor. In other substances such as low flash point oils sufficient cooling alone is difficult and impractical. (See Figure 2). The fire can be smothered by a reduction of oxygen by cutting off or reducing the air in the vapor air mixture.

Flammable vs. Combustible. There is no precise line of demarcation between a material which is flammable and one which is only combustible. For instance, wood and other such material which in solid form requires considerable energy to break it down to vapor, is termed combustible. In finely divided particles and dispersed in air this same material is easy to break down into vapor and burn. In spite of this, wood and other such substances are generally referred to as combustible.

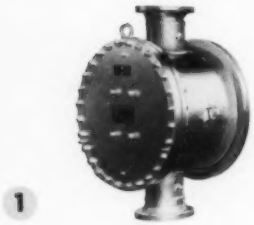
On the other hand, gasoline vapors in closed containers are normally too rich to burn; kerosine and other such oils at normal temperatures do not produce vapors to burn and triggering of ignition requires a sufficient energy not only to ignite, but to heat the oil to its flash point.

Nevertheless, these oils with flash points below 200 F. have to be classified as flammable liquids on the assumption that they may be spilling, in the open air, or spread in thin film in a manner to be easily vaporized and subject to easy ignition. Therefore, in fighting fires in accordance with what is burning the flammable and combustible terms are of no specific purpose, the classification being chiefly for prevention.

Usually, however, the combustible only can be extinguished by cooling. This method can also be used when the flammable petroleum liquid has a flash point above a temperature easily produced in the vapor space at or on the surface of the liquid involved. For instance, in the case of diesel cooling below 150 F. will extinguish.

In the case of gasoline which in open air produces vapor within the burning range at minus 45 F. (far below the freezing point of water) extinguishment by cooling it is very difficult. In fact, it cannot be done by water alone in any form.

Three Classes of Materials. If classification of materials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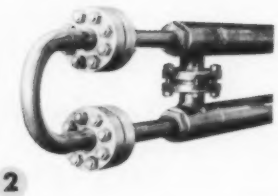
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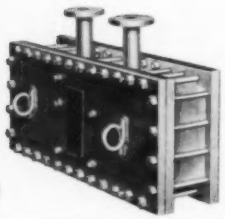
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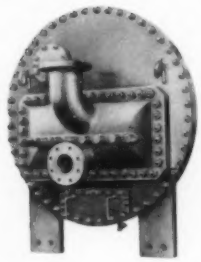
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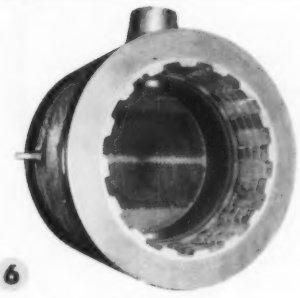
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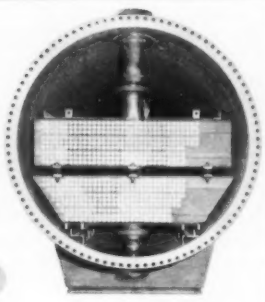
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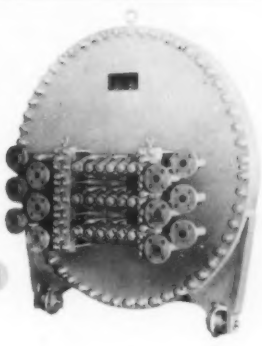
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These are the heads of some of the many different types of heat transfer apparatus available from G-R. They indicate the wide range of G-R units . . . for condensing, cooling, heating or heat exchange . . . for any liquid, vapor or gas . . . for any capacity, pressure and temperature.

G-R designs and recommendations are backed by 90 years of G-R experience, the results of G-R continuous research and product improvement, and the performance records of many thousands of G-R installations throughout industry and all over the world.

Get the benefit of these assurances of authoritative advice and successful service for your particular heat transfer requirements. There's a helpful G-R representative near you. Write us about your needs and he will promptly get in touch with you.

1. Tubular Heat Exchanger, for a great variety of services in transferring heat from one fluid to another

2. Twin G-Fin Section, a unit with a wider range of heat transfer services than any other design on the market

3. Air and Gas Cooler, for cooling the air or hydrogen from generator windings and for other gas cooling or heating services

4. Atmospheric Open Section, with Bentube or K-Fin elements for cooling or condensing services

5. Type R Evaporator, for producing distilled boiler feed make-up at moderate pressures

6. Type L Feedwater Heater, for the highest pressures encountered in central power generating stations

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8. Steam Generator, using waste heat to produce steam at boiler pressure

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GR 369

"Can you furnish an efficient heat exchanger for 2 fluids of different transfer rates?"

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One Answer...

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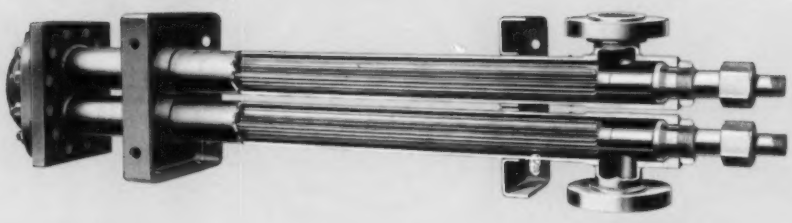

Yes, this "Universal Heat Exchanger" meets all these needs . . . and many more. It actually has the widest range of heating, cooling, condensing and heat exchange applications of any heat transfer apparatus on the market. • The G-R Twin G-Fin Section has proved its effective design and durable construction through 25 years of service. • This unit is the simplest type of heat exchanger, easy to install, economical to maintain, and with high salvage value because of its standardized design. Write for bulletin describing the many Twin G-Fin Section advantages in detail.

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are made strictly on the basis of fire extinguishment alone, it would be consistent to classify them on the basis of those which can be extinguished by (1) reduction of vapors by cooling; or reduction of air content in the mixture; (2) reduction of air volume in the vapor-air mixture only.

The temperature of a flame is dependent upon what is burning and the rate of intake of oxygen into it. For instance, acetylene burns with a lazy flame of low temperature. In fact, so low it would not provide enough energy to start combustion in magnesium unless it is in shavings or powder form. However, when pure oxygen is added, the temperature is sufficiently raised and intensified that its acetylene flame will readily melt steel.

In fighting a fire the cooling of the flame is not the object. This cannot be done. The property exposed is to be kept cool against heat input. However, the hotter the flame the more difficult it is to approach and the faster it will drive off the vapors. Thus, in both cases the flammable vapor-air mixture is harder to throw out of balance.

THE USE OF THE FIRE TRIANGLE

The fire triangle has been used for many years to show that the essentials to ignition and continued combustion consist of "Fuel" (vapor), "Air" (oxygen) and "Heat" (to ignition temperature). (See Figure 3).

It is important that emphasis be placed on the fact that to have ignition and burning, the fuel (vapor), or liquid mist, or finely divided solid must be in dispersed form and in correct volume percentage with air to readily produce vapor. For instance, the vapor space near the surface of gasoline in a closed tank contains fuel (vapor). Air (oxygen) and ignition temperature, no doubt, occurs from static spark jump from surface charge to the shell of the tank. Yet no fire occurs, because the air volume percentage is much below 94. (See Figure 4).

In using the fire triangle to show the necessity of fighting fires in accordance with what is burning, two sides only are to be dealt with. In fire prevention ignition temperature or source of ignition is important. In fire extinguishment nothing can be done about this line side of the triangle. Combustion has already started and the reaction is in process. This can only be stopped by removing or reducing both or one of the other sides of the triangle.

It is sometimes said that to extinguish a fire you eliminate at least one of the sides. Technically this is incorrect. The fire can be extinguished only by throwing the burning ratio of vapor and air out of the flammable range of the vapor of the specific material. This can be done by reducing the oxygen-air side or by reducing the fuel-vapor side. When either of these sides are eliminated or sufficiently reduced, the third side quickly vanishes.

Perhaps the fire triangle would be more effective if applied to specific groups of materials or oils, and the two sides drawn to scale of volumes percentage of the oxygen-air and fuel-vapor.

If the triangle has all sides equal, this would give air 50 percent and vapor 50 percent. This mixture of air and vapor from any petroleum flammable liquid or gas is far too much vapor and too small an amount of air. In a gasoline tank at normal temperature and near the surface of the liquid, the vapor is usually about 25 percent vapor and 75 percent air—still about 19 percent too much vapor and 19 percent too little air to burn. (See Figure 5).

Since petroleum liquids usually fall within the flammable range of from .1 to 6 percent vapor and from 99

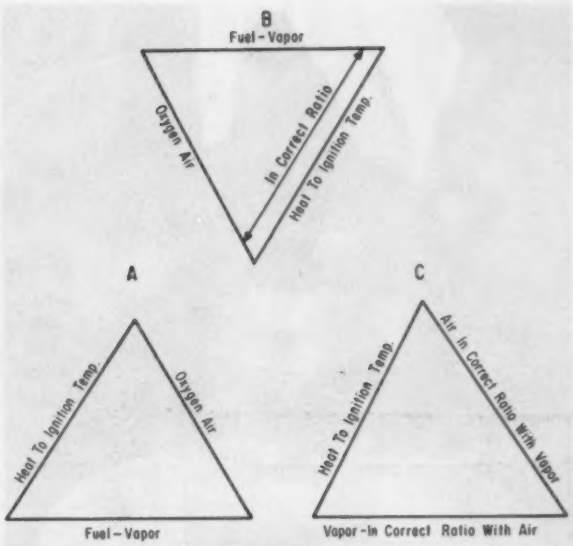

FIGURE 3—Diagram "A" illustrates the old fire triangle, with not enough emphasis on the requirement that the fuel-vapor and oxygen-air must be in correct ratio to bring the fuel into the flammable range. "B" adds a line to combine the two into correct volume percentage ratio. "C" shows how words could be added to correctly emphasize this requirement.

to 94 percent air, and petroleum gas falls within a range of from 1.9 to 9.5 percent vapor mixed with from 98.1 to 90.5 percent air, the fuel-vapor side will be about 15 times shorter than the oxygen-air side. (See Figure 6). Then to extinguish the fire, the oxygen-air side could be reduced below 94 percent for liquids and 90.5 percent for gases—or the fuel-vapor side reduced to below 1 percent for liquids and 1.9 percent for gases.

How To Reduce Vapor and Air Volumes. The rate of burn off of an oil is governed by the vapor pressure of the

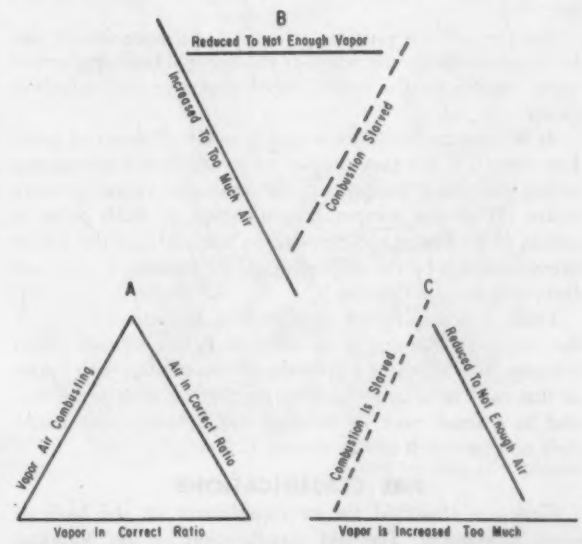

FIGURE 4—Here the corrected fire triangle is taken apart to show that it is not necessary to completely eliminate any side of the triangle, but only to reduce the air, or vapor line, to below that required in the flammable mixture. Diagram "A" shows the old triangle fire. "B" shows that the oxygen-air side is reduced in the fuel-vapor mixture. "C" shows the result of reduction of fuel-vapor from below that required.

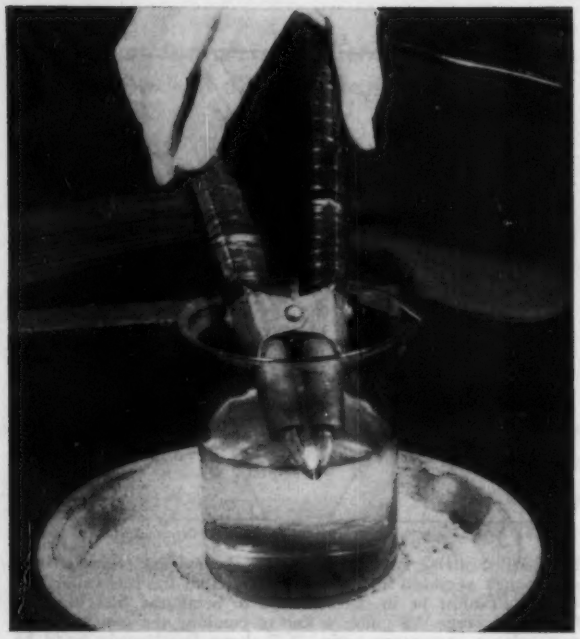

FIGURE 5—The spark in the gasoline vapor does not start a fire, even though the fire triangle has all sides in place. There is no fire because the vapor and air is not mixed in correct volumes to be within the flammable range. In this case the vapor is between 15 and 25 percent at the gasoline's surface, thus the air content is much too low to start a fire.

oil to project the vapors into the flammable range with air. The faster air (oxygen) is brought into the mixture, the faster will be the burn away—and the more difficult it will be to break up this flammable range.

In some oils it is easier to reduce the vapor rate to below that required in the flammable mixture. This is dependent upon the flash point and vapor pressure of the material, and whether the fire is a contained fire or an uncontained fire.

For fire fighting purposes, the vapor pressure should also be given to determine whether the fire will be extinguished more readily by the reduction of vapor or the reduction of air.

It is evident from the 7 to 15 vapor pressure of gasoline that this product cannot be extinguished by cooling alone, the chief method of reducing the vapor pressure below .18 or the temperature to below its flash point of minus 45 F. The vapor rate can be reduced and the flames brought down by the rolling of colder gasoline to the surface, but not extinguished.

Final extinguishment requires the reduction of air in the vapor-air flammable mixture to below 94 percent in volume. The air can be prevented from mixing with vapor in this case in a large tank by blanketing with fire foam, and in a small tank by diluting the air with inert materials or gases such as dry chemical.

FIRE CLASSIFICATIONS

Fires are classified for extinguishment on the basis of what is burning. The old classification by the National Fire Protection Association was essentially as follows:—

Class "A"—Wood, rubbish, paper and other such solids.

Class "B"—Oil and oil soaked materials.

Class "C"—Electrically charged equipment.

These classifications had to put all of one thing under one classification. Metal and plastic fires had not come into the picture.

Under these classifications, Class "A" fires could be extinguished by cooling with water. Other agencies classified for Class "A" fires had to be coolants. Although oils with flash points above the cooling temperature of water such as diesels, kerosines and fuel oils could be extinguished with water stream or spray cooling they had to be classed with other oil which could not be so extinguished. This was because in large quantity in containers water cooling could not be applied with the devices at hand and foam was used. Of course, the electric classification was a precaution against electric shock.

It appears that fire fighting equipment suitability could well include metal fires, and further breakdown to include liquids and gaseous hydrocarbons into those chemically active substances such as carbon bisulfide, acetylene, and hydrogen which have low ignition energy requirements; liquid and gaseous hydrocarbons including petroleum and its products; and oxygen containing organic chemicals such as alcohols, ethers, etc., which have higher ignition energy requirements.

Petroleum Fires. In attempting to classify petroleum fires, not only certain fine points of characteristics must be taken into consideration, but also fire surroundings and specifically whether the oil is at rest or is in motion—trapped or on the loose. On the basis of characteristics, classification for procedure and equipment must take into consideration the readiness of the specific oil to give off vapor to mix with air in the flammable range.

It has been found by experience that the best classification of oil fires for the purpose of fire fighting training is as follows:

1. *High Flash Point Petroleum Liquid Fires.* This includes oils with flash points of over 100 F. and not over 200 F., i.e., kerosines, diesels, fuel oils and some crude oils. Types would include high flash point contained and uncontained oil fires. Also high flash point contained oil contaminated with low flash point oil.

2. *Combustible Solids and Liquids of Petroleum* with flash points above 200 F., i.e., asphalt and some fuel oils.

3. *Low Flash Point Petroleum Liquid Fires.* This class includes flammable liquid fires in oils with flash points below 100 F., and with vapor pressures of not over 15 pounds per square inch, i.e., gasolines, some jet fuels and some crude oils. Types would include contained and uncontained fires.

4. *Hydrocarbon Gases,* i.e., liquefied petroleum gases which are held in liquid form by their own vapor pressure. Also, butane, propane and other such gases held in liquid form by vapor pressures above 15 psi, or at extremely low temperatures.

5. *Crude Oil Tank Fires.*

Part 12, the last article in the Risinger series, will group petroleum fires under the general headings of contained and uncontained fires. In each group fires will be discussed and illustrated on the basis of the classifications given in this article, with the exception of crude oil which was outlined in Part 3. How different types of fires can best be fought and the most suited equipment to use in accordance with what is burning will also be discussed next month.

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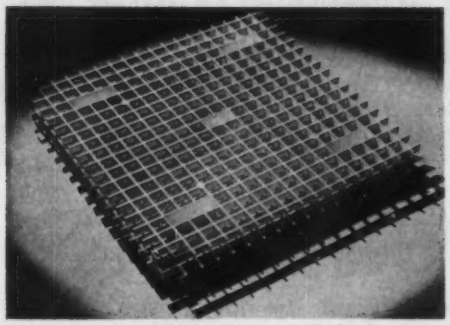
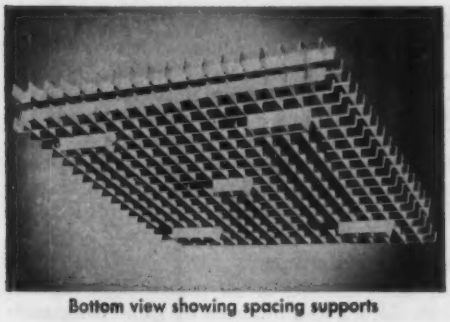


Overall top view as installed

Side view of packing as installed



Bottom view showing spacing supports

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This revolutionary packing provides greater cooling surface — greater overall heat transfer; yet construction is open, and pressure drop low.

"Poly-Grid" is available in high impact polystyrene or linear-polyethylene to meet all water conditions.

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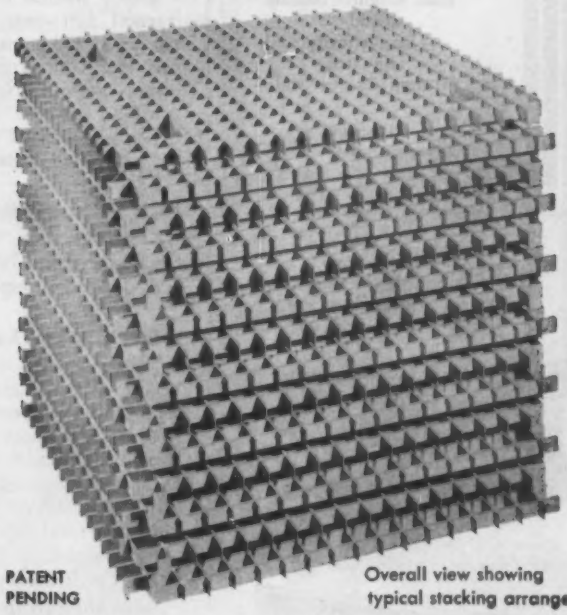

PATENT PENDING

Overall view showing typical stacking arrangement

Contact your nearest Fluor Representative for details.

POLY-GRID can be easily installed in any counterflow induced draft cooling tower—regardless of make or model!

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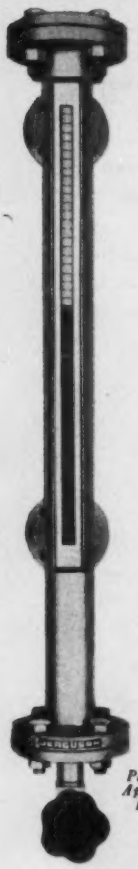

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If Oil Could Speak

If oil could speak it would have many fascinating truths to tell the non-oil public—truths that would win thousands of new friends for the oil industry.

But, oil can't speak—you can. You, as an individual, can win many new friends for the oil industry if you will pass the true facts on to your non-oil industry friends.

Here are some of those true facts. They are being presented for one purpose: To keep you posted on your industry, so you can tell the story oil is unable to relate.

Read these facts. You will find them informative—and interesting.

"If Oil Could Speak" it would tell the American public:

What Does the Oil Industry Do With the Consumer's Dollar?

Much of the industry's income is plowed back into finding and developing new oil reserves. An average of eight wells was drilled for each million dollars of petroleum production income during the past year. In North Dakota alone, oil companies have invested more than 200 million dollars searching for and producing oil.

How Much Gasoline Are We Using?

Every second of the day, more than 1772 gallons of gasoline were burned last year by the nations' gasoline-powered vehicles. Taking the lead in the consumption of this record-breaking 56 billion gallons of fuel was California, with 5⅓ billion gallons. Texas followed with 4½ billion gallons, New York with 3⅔ billion, and Ohio with just over 3 billion gallons. Maintaining adequate supplies of gasoline is an ever-present challenge to oil men who continue to break their own records for filling America's oil needs.

Do "Big" Companies Control the Oil Industry?

Definitely not. To give but one example, of all wells completed last year, more than 78 percent were owned and financed by small companies or independent operators.

What Is Being Done to Insure Future Supply?

Some of the wealth that assures America's future prosperity is being "Banked" underground—at a cost of millions of dollars to the oil industry. One Texas company has begun storing its supplies in a depleted gas field—the deepest underground storage project in the world today. Up to 30 billion cubic feet of gas will be banked for consumer's convenience at depths of more than 8000 feet. Underground storage figures among the most modern methods used by ingenious oil men to establish and maintain vital supplies of oil products for the nation.

Is the Oil Industry a Good Employer?

According to the Bureau of Labor Statistics, the average hourly earnings for workers in petroleum refining last year was $2.46, compared with $1.88 for workers in all other manufacturing industries!

What Is Being Done to Upgrade Oil Product Quality?

More than 65 percent of the $450 million spent by refiners last year for new refining capacity went to improve the quality of gasolines, home heating oils and other petroleum products.

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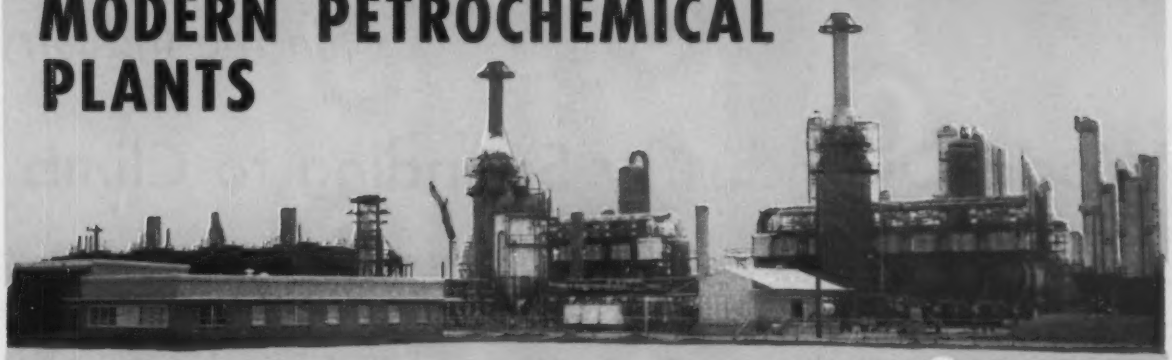

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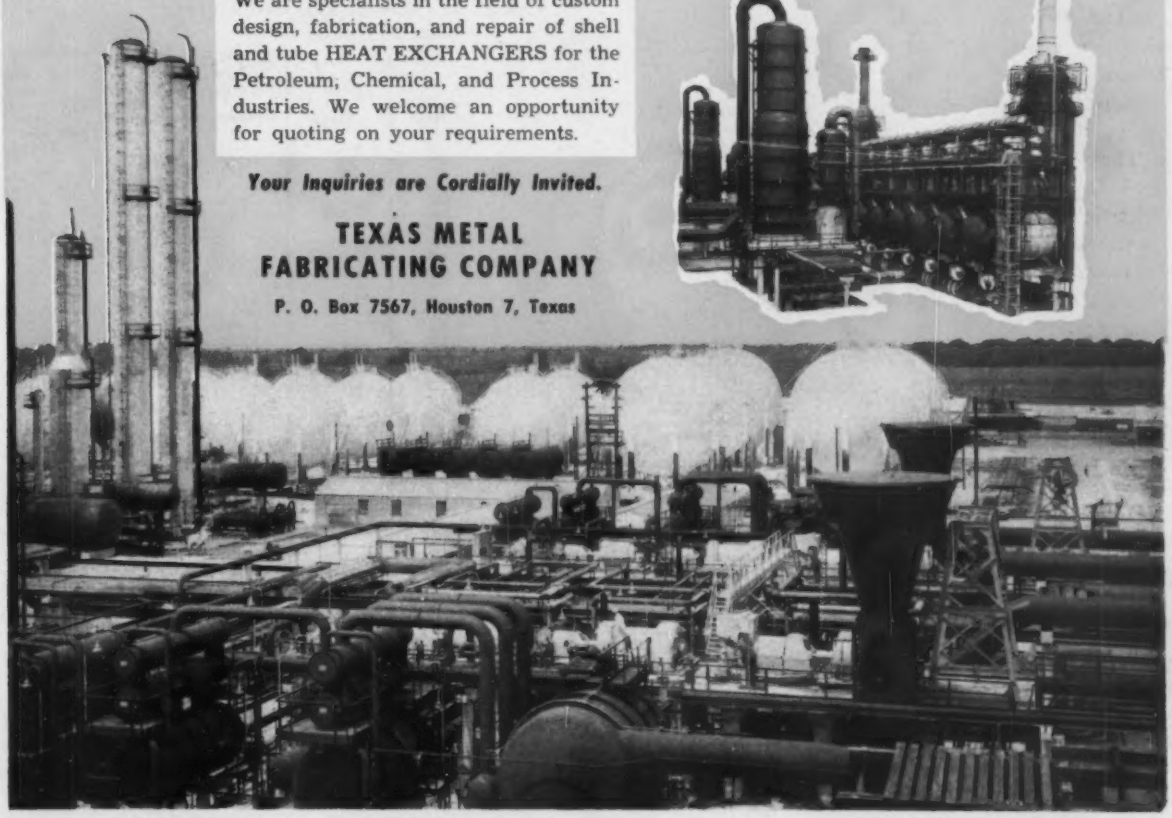

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What's Happening . . .

. . . in the Industry

World Oil Industry Spending to Climb

Facilities must be expanded to keep abreast of anticipated 7 percent growth in petroleum demand.

CAPITAL EXPENDITURES by the petroleum industry of the Free World will regularly increase about 6 percent per year during the next 10 years, although the increase will temporarily drop to about 1.2 percent in 1958. Spending in the U. S. will increase around 5 percent annually, and that in other free countries about 8 percent per year.

The steady increase in spending is expected because of the anticipated continuing strong growth in demand for petroleum The Free World demand is expected to rise about 7 percent per year, with U. S. consumption increasing about 4 percent annually and demand in other free countries climbing about 9 percent per year. (Table 2.)

These figures are estimates of Frederick G. Coqueron, of the petroleum department of the Chase Manhattan Bank, New York. They are embodied in a comprehensive, detailed 10 year forecast of capital expenditures. The figures on spending are based, in turn, on the same bank's 10 year forecast of Free World petroleum supply and demand, in the pamphlet, "Future Growth of the World Petroleum Industry."

Spending in 1958. Capital expenditures of the Free World petroleum industry will total about $10,350,000,000 in 1958. That will be an increase of 1.2 percent over the $10,225,000,000 being spent in 1957.

The spending of 1957 represents an increase of 4.3 percent over the $9,800,000,000 spent in 1956. The latter figure was 18.9 percent over the $8,245,000,000 spent in 1955.

The indicated slowing down of the growth in spending in 1957 and 1958 involves foreign free countries more than the U. S. It reflects particularly the irregular spending rates for costly concessions in Venezuela. There was no awarding of Venezuelan concessions in 1955. But operators spent $310 million for Venezuelan concessions in 1956 and $375 million in 1957.

The Free World total capital expenditures of $10,350,000,000 in 1958 will include $6,150,000,000 or 59.4 percent for production facilities, $1,675,000,000 or 16.2 percent for refineries and chemical plants, and $2,525,000,000 or 24.4 percent for transportation, marketing, and other facilities.

U. S. and Foreign. The U. S. expenditures of $6,650,000,000 in 1958 will include $4,850,000,000 or 73 percent for production, $900 million or 13.5 percent for refineries and chemical plants, and $900 million or 13.5 percent for transportation, marketing and other items.

The Free Foreign expenditures of $3,700,000,000 estimated for 1958 will

TABLE 1

Estimated Capital Expenditures of the Free World Petroleum Industry in Years 1955-1966

(Source: Chase Manhattan Bank, New York)

MILLION DOLLARS

YEAR	Production Division	Refineries and Chemical Plants	Transportation and Marketing	Total	% Gain Over Previous Year
UNITED STATES					
1955	....	....	....	5,600	..
1956	4,475	825	750	6,050	8.0
1957	4,600	875	850	6,325	4.2
1958	4,850	900	900	6,650	5.1
Percent of Total	73.0	13.5	13.5	100.0	..
1959	5,100	1,000	950	7,050	6.0
1960	5,400	1,025	1,000	7,425	5.3
1961	5,675	1,050	1,100	7,825	5.3
1957-1961	25,625	4,850	4,800	35,275	..
1962	5,900	1,150	1,175	8,225	5.1
1963	6,125	1,200	1,250	8,575	4.2
1964	6,400	1,275	1,325	9,000	5.0
1965	6,625	1,325	1,450	9,400	4.4
1966	6,900	1,375	1,500	9,775	4.0
1962-1966	31,950	6,325	6,700	44,975	..
1957-1966	57,575	11,175	11,500	80,250	..
FREE FOREIGN					
1955	....	....	....	2,645	..
1956	*1,550	725	1,475	3,750	41.8
1957	*1,600	750	1,550	3,900	4.0
1958	1,300	775	1,625	3,700	—5.4
Percent of Total	35.1	21.0	43.9	100.0	..
1959	1,425	850	1,700	3,975	7.4
1960	1,550	900	1,800	4,250	6.9
1961	1,700	1,000	1,900	4,600	8.2
1957-1961	7,575	4,275	8,575	20,425	..
1962	1,825	1,100	2,025	4,950	7.6
1963	2,050	1,200	2,150	5,400	9.1
1964	2,225	1,300	2 300	5,825	7.9
1965	2,450	1,400	2 50	6,300	8.1
1966	2,725	1,500	2,625	6,850	8.7
1962-1966	11,275	6,500	11,550	29,325	..
1957-1966	18,850	10,775	20,125	49,750	..

* Free Foreign production expenditures include costs of Venezuelan concessions amounting to $310 million in 1956 and $375 million in 1957.

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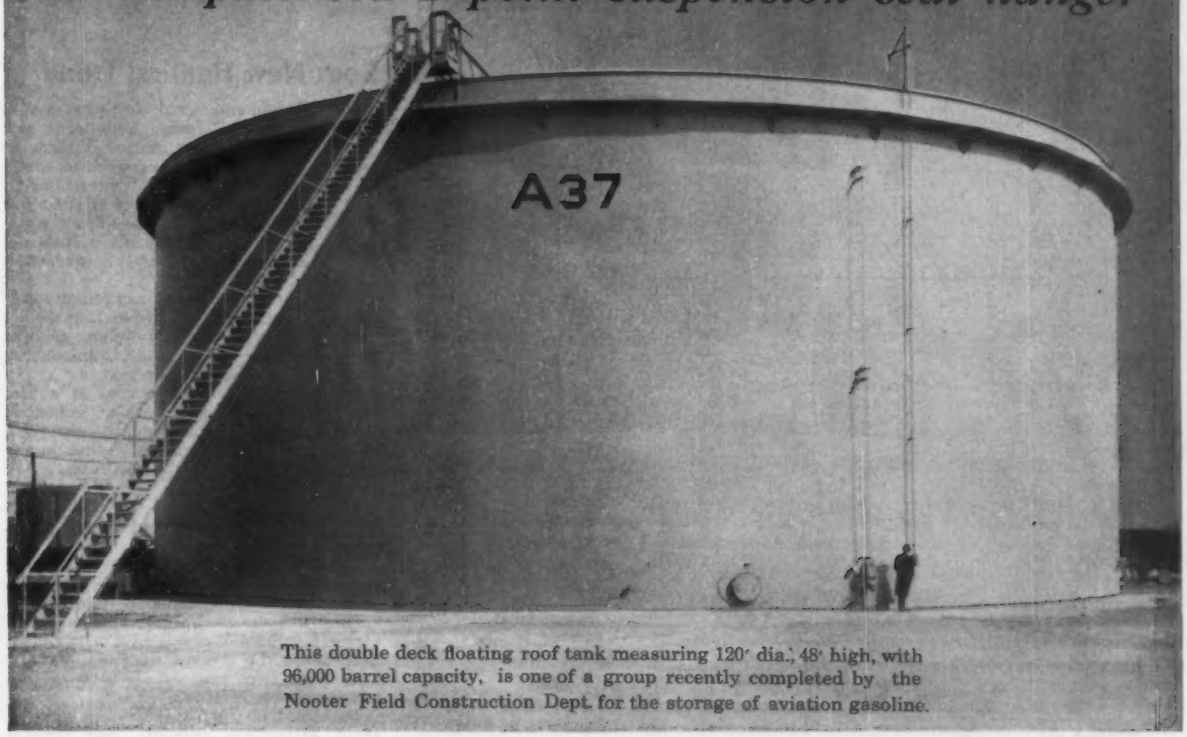
new floating roof tank

with patented 2-point suspension seal hanger



This double deck floating roof tank measuring 120′ dia., 48′ high, with 96,000 barrel capacity, is one of a group recently completed by the Nooter Field Construction Dept. for the storage of aviation gasoline.

The floating roof oil and gasoline storage tanks fabricated and erected by Nooter are now distinguished by the new patented Nooter seal.

Because this seal exerts a uniform outward pressure over the entire height of the sealing shoe, a better seal is achieved, and abrasion at any one point is reduced.

Another important feature of the seal: all operating mechanism is placed beneath the roof, leaving the deck clear and neat.

The Nooter seal is adaptable, without size limitation, to double-deck, pontoon and pan-type roofs, or any existing type of floating roof.

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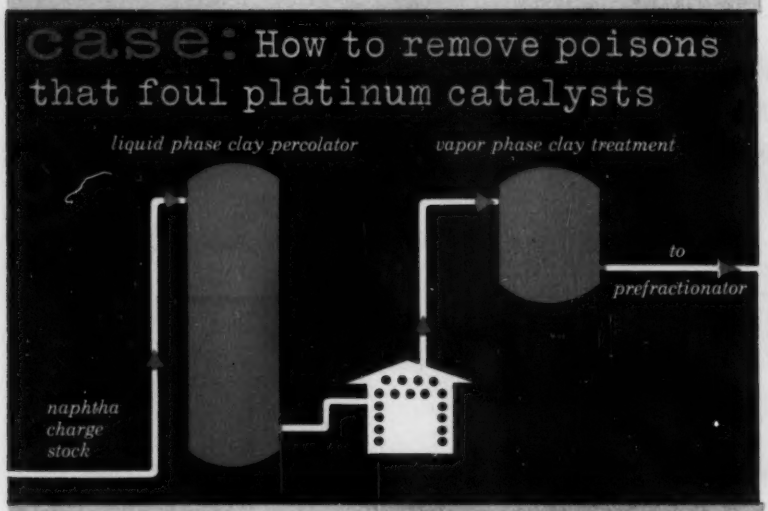

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Attapulgite Adsorbent Report: Feed stock passes through Attapulgite Clay-packed "guard case" equipment where troublemaking constituents are removed from the stream (some need only be present at *10 parts per billion* to temporarily—even permanently—foul the catalyst.) Poisons removed include: Arsenic—present in the crude or picked up along the way; Nitrogen—from crude or other sources (these by adsorption); Tetraethyl Lead—from refinery cross-contamination; Alkyl Sulfur compounds (these by catalysis).

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2714 Essex Turnpike, Menlo Park, N.J.

Leaders in creative use of non-metallic minerals

ATTAPULGITE (*Attapulgus*)
ACTIVATED BAUXITE (*Porocel*)
KAOLIN (*Edgar • ASPs*)
LIMESTONE (*Chemstone*)
SPEEDI-DRI FLOOR ABSORBENTS

What's Happening. . .

include $1.3 billion or 35.1 percent for production facilities, $775 million or 21 percent for refineries and chemical plants, and $1,625,000,000 or 43.9 percent for transportation, marketing and other properties.

Sees New Heating Trend

The Bituminous Coal Institute sees a trend developing "among both large and small commercial and industrial users to convert oil and gas heating units to coal."

The institute said that "conversions to coal began early last year as oil and gas prices rose, and the most significant number of changecovers from other fuels occurred in the Eastern and Southeastern states and the Middle West."

Coal registered big gains in laundry and dairy industries, as well as in commercial establishments such as shopping centers, apartments, hotels and motels, universities and hospitals, the institute said.

Industrial movement to coal as a fuel "was headed by metal-working industries in the North and by textile, chemical, aluminum and paper manufacturers in the South," according to the institute.

Lube Plant to Start Up Soon

A new lube plant which is designed to supply 60 percent of the nation's motor oil and grease requirements is due to be opened this month by Yacimientos Petroliferos/Fiscales Bolivianos in Cochabamba, Bolivia. At the present time the plant is undergoing experimental tests with the assistance of a U.S. lube expert.

Bolivian lube imports have been running about $1 million annually, and imports this year may be up 25 percent. The new lube installation is 80 percent owned by YPFB and 20 percent by Coper, a private Bolivian company.

Write-Off Extension Denied Commerce for New Refinery

Commerce Oil Refining Corp. has been denied extension for its previous rapid tax write-off certificate on the 40,000 bpd refinery it will build at Jamestown, R. I.

Reason given by the Office of Defense Mobilization for turning down the extension was that there was a conflict with adjoining naval installations. Evidently the denial is part of the new ODM policy to limit approval for extensions. Although all goals for write-offs have been closed for some time, extensions were being granted for previously approved certificates, providing reasonable explanations were offered for the delay in starting projects.

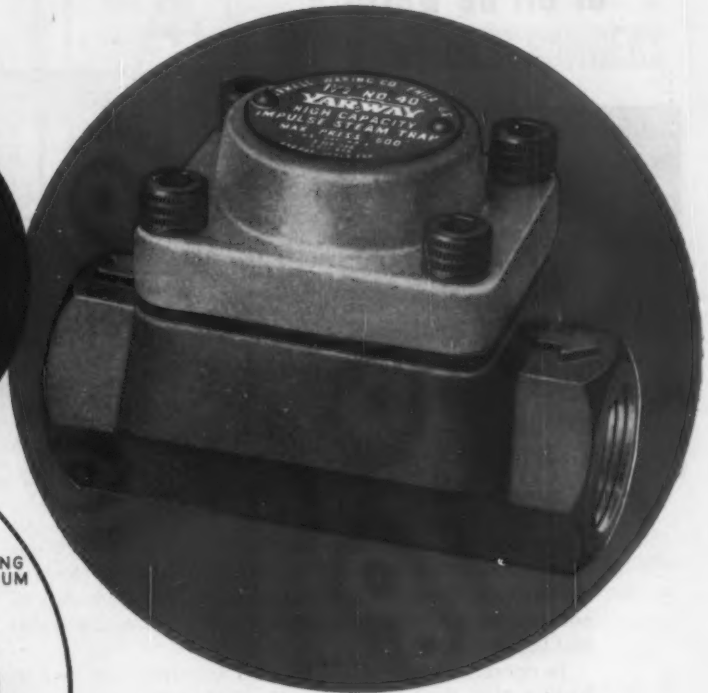
Cities Service Buys Plant

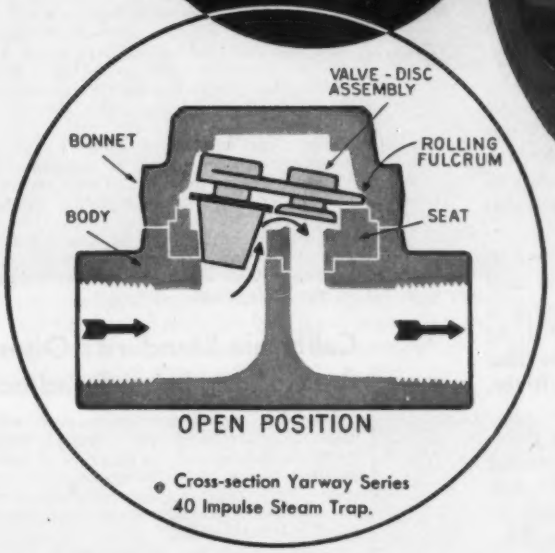
Purchase by Cities Service Oil Co., of the Lehman, West Texas, gasoline plant from Llano Grande Corp., Houston was announced last month by Robert L. Kidd, Bartlesville, Okla., president of Cities Service Oil Co.

The plant is located in Cochran County, four miles south of Lehman and 25 miles west of Levelland. Through an extensive gathering system, the plant serves the West

This YARWAY IMPULSE STEAM TRAP is for extra heavy* condensate loads

YARWAY SERIES 40





Cross-section Yarway Series 40 Impulse Steam Trap.

*Examples: At 10 psig, ½", 1300 lbs./hr.; 2", 10,000 lbs./hr.
At 100 psig, ¾", 5600 lbs./hr.; 2½", 62,000 lbs./hr.

STANDARD SERIES 60 YARWAY IMPULSE TRAP

For normal steam trap applications the standard Series 60 Yarway Impulse Steam Trap is recommended. For *extra light* condensate loads use the ½" Yarway 20-A Impulse Steam Trap.

Send for Yarway Bulletin T-1739X.

The famous Yarway "impulse" principle of thermodynamics that revolutionized steam trapping many years ago, is now applied to a steam trap for extra heavy condensate loads—the Series 40 Impulse Steam Trap. Users report with this trap they obtain quicker heating, higher and more even temperatures in their process equipment.

It also incorporates all the other advantages of earlier Impulse trap designs, such as—immediate response to load changes, no air binding, light weight and small size. Maintenance is low, thanks to stainless steel body and working parts.

High condensate capacity of Yarway Series 40 Impulse Steam Traps makes them ideal for heavy condensate loads on large autoclaves, cooking kettles, dryers, heat exchangers, heating coils, presses, unit heaters, etc.

Suitable for all pressures up to 600 lbs. maximum, without change or adjustment. Operates against back pressures up to 50%. Five sizes, ½", ¾", 1½", 2" and 2½".

Your Yarway man will furnish a Yarway "40" for 90-day free trial in your plant without obligation, or write for Yarway Bulletin T-1746.

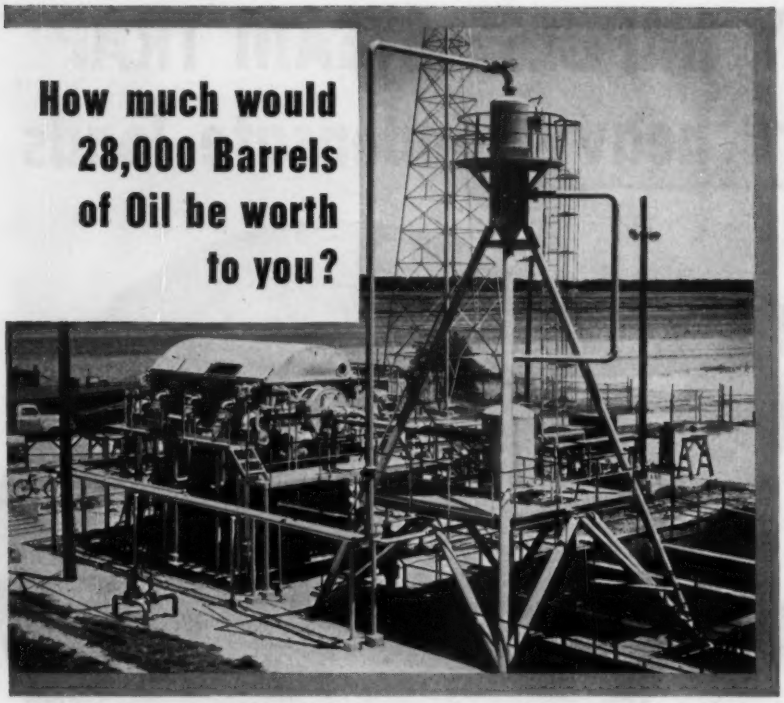
YARNALL-WARING COMPANY
128 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY

IMPULSE® STEAM TRAP

OVER 1,000,000 YARWAY IMPULSE STEAM TRAPS USED

For more data on advertised products, use Readers' Service Cards, last page.



That's what Cities Service Refining Co. reclaimed *in one year* with this slop oil filter station at Lake Charles, La. To be exact, it was 28,734 barrels of oil – all from slop oil and separator bottoms emulsions which previous treatment had failed to break.

In operation, 50 bags of Dicalite Speedplus are used to build a 2½"-thick precoat on the 400 sq/ft stainless steel screen of the Eimco vacuum precoat filter. The charge is usually separator bottoms (60%) and slop oil (40%). At a drum speed of ⅓ rpm, with knife cut of .003", the filter cycle is 40 hours. Flowrates range from 2 to 10 gal/ft²/hr, averaging about 4.

Similar slop oil filtration systems, using a Dicalite filter-aid, have been in use during the past few years in several refineries. Their operating data show that slop oil filtration is *not* an added cost . . . frequently these filter systems recover their entire investment in the first year. From there on, their output is largely pure profit – with the added advantage of no waste disposal problem, since the separated water contains so little oil that it may be discharged without stream pollution, or may be recycled for some process operations.

A Dicalite service engineer will be glad to discuss this problem with you, and the services of the Dicalite Laboratory are at your disposal for tests. Just write . . .

Dependable GLC GREAT LAKES Dicalite® DIATOMACEOUS MATERIALS

Dicalite Division, Great Lakes Carbon Corporation, 612 S. Flower St., Los Angeles 17, Calif.

What's Happening . . .

Levelland field. It was designed and constructed by Tellepsen Construction Co., Houston, contractor, and was placed on stream early in 1955. The plant was designed to process 25 million cubic feet of gas daily.

Navy Delays Shale Lease

Navy plans to advertise for bids on private research activities at its Rifle, Colo., shale oil plant have been postponed until the Justice Department can settle the question of whether or not the Navy actually has title to the plant.

Captain A. S. Miller, director of Naval Petroleum reserves office had hoped to advertise for bids in early October, but the question of jurisdiction which has come up between the Navy and the Department of the Interior has delayed the plans.

Under Miller's plan, no more federal funds would be spent at the plant. Instead, it would be leased to one company, or a group of companies, on the condition that a specified minimum amount of research work would be conducted. A lease such as this would be effective in halting a bill by House Armed Services Committee Chairman, Vinson (D-Ga.) calling for a $14 million research program at the Rifle plant. This program would be conducted by a private contractor under the supervision of the Navy.

The Navy's plan to lease the plant, however, would still be in keeping with Vinson's desire that the Navy, and not the Bureau of Mines, maintain control over the plant.

Miller indicated that he has a list of at least 60 firms, including many oil companies, that he would contact for bidding on the Rifle plant.

California Standard's Offer Breaks Long Labor Deadlock

Late last month the four-month stalemate in bargaining on contract items between Standard of California and Independent Union of Petroleum Workers was ended by a new company offer described by top union officials as a "momentous benefits breakthrough."

Highlights of Standard's offer as outlined by a union official include:

1. Standard paying full cost of employe hospital medical coverage, a cherished union goal for more than seven years.

2. Employes hereafter qualifying at six months rather than a year for sick pay, industrial injury, and life insurance benefits.

3. Future annuitants as well as active employes sharing in life insurance benefits; about double those now in effect.

4. Vesting in company contributions and pensions starting at 15 rather than the present 25 years service.

5. Union suggestions being frankly acknowledged by the company as having helped shape revised benefits structure.

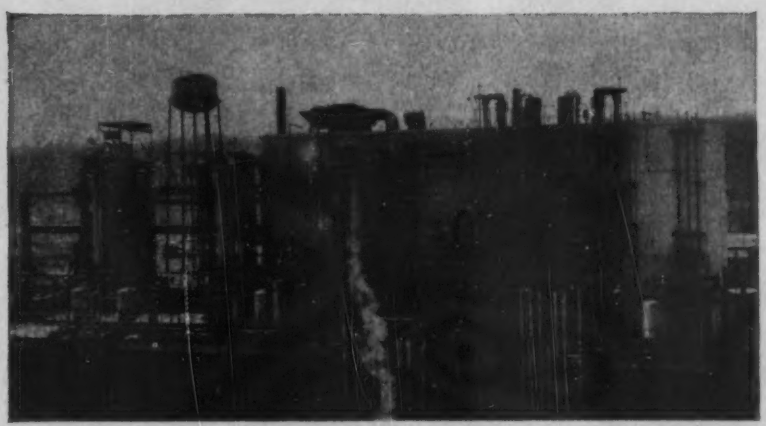
In addition to the changes in principles, Standard's offer includes substantial increases in nearly all benefits scheduled with no cut-backs from present norms at any point.

A union spokesman wrapped it up by saying that, "Standard's demonstrated will-

News from
National Carbon Company
Division of Union Carbide Corporation · 30 East 42nd Street, New York 17, N. Y.
Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. IN CANADA: Union Carbide Canada Limited, Toronto

"KARBATE" IMPERVIOUS GRAPHITE SHELL AND TUBE HEAT EXCHANGERS PROVE THEIR ECONOMY IN COOLING CORROSIVE GASES

Gas coolers of "Karbate" Impervious Graphite cost less and last longer than coolers made of less corrosion-resistant materials.



Ten "Karbate" Impervious Graphite Shell And Tube Heat Exchangers cooling and condensing mixtures of organic vapors and hydrogen chloride. Units are arranged in pairs—uninsulated unit in each pair has plant cooling water on shell side; insulated unit is refrigerated.

These standard "Karbate" heat exchangers have 685-⅞" I. D. "Karbate" tubes assembled between "Karbate" tube sheets in 45" diameter steel shells. Corrosive water-saturated sulfur dioxide gas, which contains considerable entrained sulfuric acid, will enter and leave tube sides through 24" diameter connections on "Haveg" phenolic resin covers.

National Carbon provides complete Technical Service—An experienced technical staff designs and rates "Karbate" Shell and Tube Heat Exchangers manufactured and guaranteed by National Carbon. Dr. D. Q. Kern, well-known consultant and author of PROCESS HEAT TRANSFER, serves as an advisor to this group.

Particularly significant today is the economical cooling of corrosive gases. "Karbate" Impervious Graphite Heat Exchangers have the corrosion resistance, high thermal conductivity, immunity to thermal shock, and moderate cost vital to this service.

For cooling corrosive gases, "Karbate" Exchangers operate either horizontally or vertically, usually with the corrosive gas inside the "Karbate" tubes and with the coolant in the steel shell. These exchangers are furnished with shells of "Haveg" phenolic resin, impervious graphite, rubber or glass-lined steel for operation with corrosive gas on the outside of the "Karbate" tubes.

A complete line of "Karbate" Heat Exchangers is available in sixteen shell sizes from 6" I.D. to 45" I.D. with tube lengths of 6', 9', 12', 14', and 16'. Standard components are carried in stock for immediate assembly of units having up to 3585 sq. ft. of heat transfer surface.

For full details, request **Catalog Section S-6800NL**

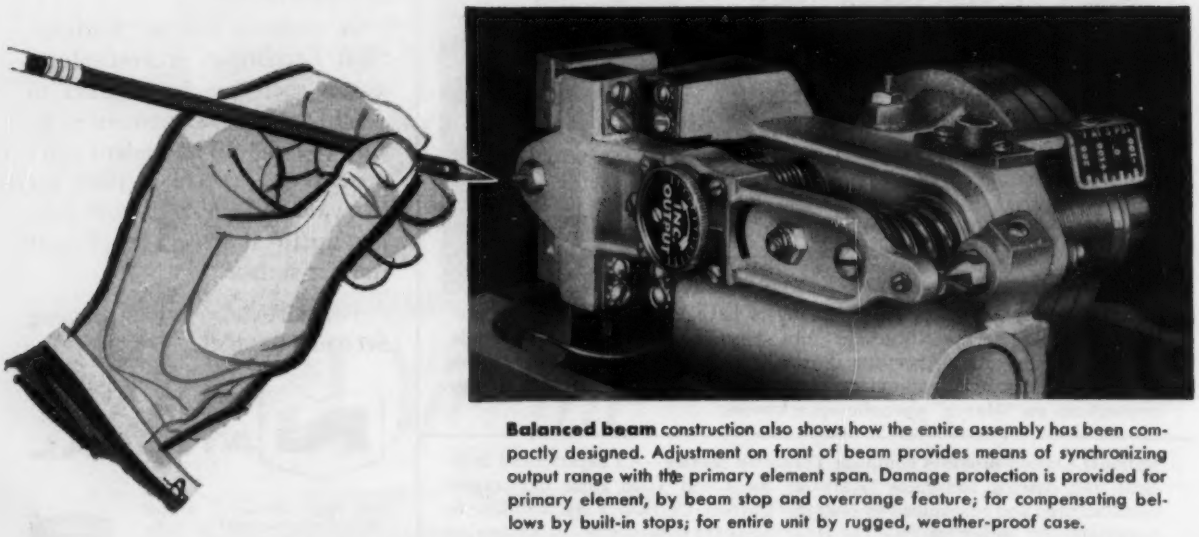
NATIONAL TRADE-MARK

The terms "National", "N" and Shield Device, "Karbate" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

UNION CARBIDE

A Mason-Neilan *Design Exclusive*

This oscillating test mount demonstrates the effectiveness of Masoneilan "Balanced Beam" design. Output pressure does not change, regardless of transmitter position.



Balanced beam construction also shows how the entire assembly has been compactly designed. Adjustment on front of beam provides means of synchronizing output range with the primary element span. Damage protection is provided for primary element, by beam stop and overrange feature; for compensating bellows by built-in stops; for entire unit by rugged, weather-proof case.

Masoneilan Pressure and Temperature Transmitters use Balanced Beam to Prevent Zero Shift

The new Masoneilan Transmitters feature a distinctive balanced beam design which eliminates positional error

In addition, these transmitters offer several other important design advances. Unit construction simplifies change or removal of subassemblies; All adjustments are visible and accessible; Large pilot capacity insures fast operation with long transmission lines; and Unit is compensated for ambient temperature and barometric pressure.

Write for Bulletin

Complete information and data on this new instrument is now available. Write for your copy or ask for details at your nearest Mason-Neilan office.

MASON-NEILAN

Division of Worthington Corporation

51 NAHATAN STREET, NORWOOD, MASS.

SEVENTY-FIFTH 75 ANNIVERSARY 1882-1957

Sales Offices or Distributors in the Following Cities:
New York • Syracuse • Chicago • St. Louis • Tulsa • Philadelphia
Houston • Atlanta • Cleveland • Cincinnati • Kansas City • Phoenix
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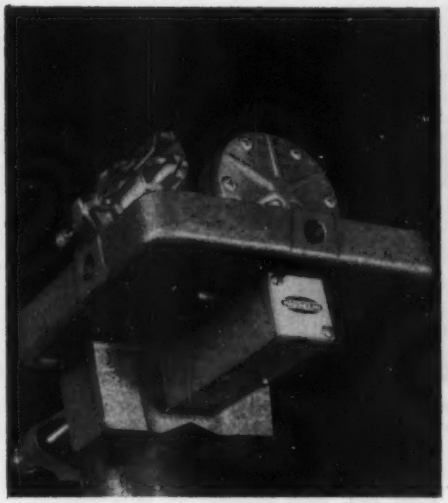
Appleton • Birmingham • New Orleans • Seattle • Jacksonville
Wilmington • Mason-Neilan Regulator Co., Ltd., Montreal & Toronto



The derivative unit compensates for lags in the thermal system. It can be quickly added on the underside of base plate, and requires no tubing or fittings. Mounting block attaches to flat surface or forms clamp for pipe.

Unit Subassembly construction permits simplified removal or change of primary element; compensating bellows; feed-back bellows; pilot; range span adjustment; derivative unit; and gasketless nozzle — any or all without disturbing beam assembly in any way. Integral Receiver Gage is another Masoneilan feature — can be mounted directly on base plate without external connections.

For more data on advertised products, use Readers' Service Cards, last page.

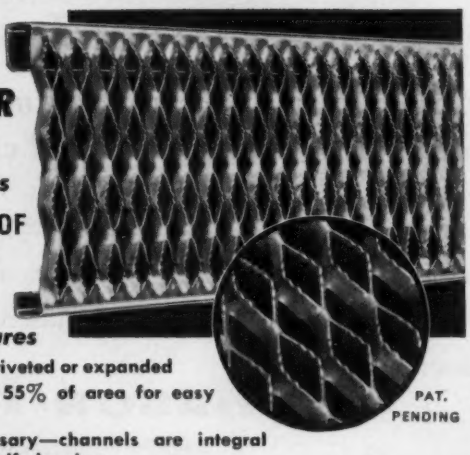
two superior open steel
FLOOR GRATINGS
BY GLOBE

1 Safety GRIP-STRUT®

FOR MAXIMUM SAFETY ALL OVER YOUR PLANT

Important Safety Features

★ FIRE PROOF ★ SLIP PROOF
★ MAXIMUM STRENGTH
★ MINIMUM WEIGHT



Important Economy Features

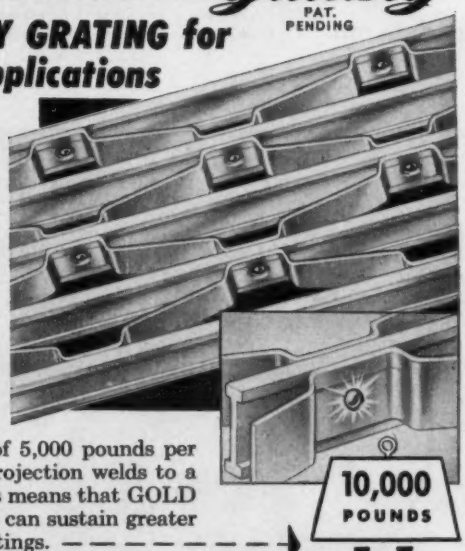
★ All one piece, not welded, riveted or expanded
★ Open space in excess of 55% of area for easy access of light and air
★ No extra supports necessary—channels are integral part of the material. ★ Self cleaning
★ Cut and installed like lumber by your own maintenance force. ★ Low in original cost. ★ For balconies, no secondary sprinkler heads needed

Ideal for work platforms, stair and ladder steps, flooring, balconies, catwalks, machinery guards, fire escapes and for original equipment safety treads.

2 GOLD NUGGET® WELDED grating PAT. PENDING

The QUALITY GRATING for Heavy Duty Applications

★ ⅜" projection weld nugget for greater rigidity and strength
★ Vertical alignment of the main load bar assured
★ All bars are load carrying bars including secondary bars
★ Anti-skid pattern



PROJECTION WELD

Each secondary load bar (A), as projected welded to the primary load bar (B) has a shear strength of 5,000 pounds per weld. There are 28 such projection welds to a square foot of grating. This means that GOLD NUGGET Welded Grating can sustain greater shock loads than other gratings.

For the complete details of these revolutionary new gratings, write for new catalogs today. Distributors in all principal cities. Consult the yellow pages in your phone book under "GRATING".

108

PRODUCTS DIVISION
The GLOBE Company MANUFACTURERS SINCE 1914
4008 SOUTH PRINCETON AVENUE • CHICAGO 9, ILLINOIS

What's Happening . . .

ingness to concede on benefit principles unchanged for over 40 years encourages us to renew negotiations on the few remaining contract items which to date have blocked a settlement."

API Certificates Awarded

Thirty-seven oil men were given Certificates of Appreciation at the 37th annual meeting of the American Petroleum Institute in Chicago recently.

Certificates of Appreciation are presented in recognition of long or valuable service to the oil industry through the Institute. Those who received them are:

Fundamental Research: Frank Rinker Clark, retired, Ohio Oil Co., Tulsa; H. W. Field, Atlantic Refining Co, Philadelphia; L. Laskaris, Atlantic Refining Co., Philadelphia; Sherman S. Shaffer, Humble Oil and Refining Co., Baytown, Texas.

Safety and Fire Protection: H. W. Boggess, Sinclair Oil & Gas Co., Tulsa.

Oil Information Committee: R. W. Abrahamson, Continental Oil Co., Minneapolis; W. D. Cross, Jr., Sinclair Refining Co, Chicago; E. A. Cunningham, Shell Oil Co., Baltimore; Joe T. Dickerson, Shell Pipe Line Corp., Houston; G. R. Fenner, Pure Oil Co., Columbus, Ohio; D. M. Hills, Sinclair Refining Co., New York; Frederick H. Meeder, Richfield Oil Corp. of New York; H. E. Prunty, Standard Oil Company (Indiana), Des Moines.

American Petroleum Industries Committee: Austin T. Foster, Socony Mobil Oil Co., New York.

Committee on Petroleum Statistics: Henry N. F. Schwall, Shell Oil Co., New York.

High Temperature Resins

A new approach to high temperature was revealed recently before the Isocyanate Symposium of the Society of Plastics Engineers at Minneapolis, Minnesota.

Urethane resins based on a new polyfunctional material, Polymethylene Polyphenylisocyanate, can be made having substantially improved physical properties at elevated temperatures. This new approach has opened up possibilities of urethane materials that were formerly limited to more costly and less versatile plastics.

Development efforts to date have been concentrated on variations in the polyester and polyether components to achieve specific characteristics. Rigid foams can be made that retain 70 percent of their room-temperature strength at temperatures as high as 400 F. with a shrinkage of only two percent. This represents an increase of more than 150 F. over the useful temperature at which conventional urethane foams can be used.

– Changing Times –

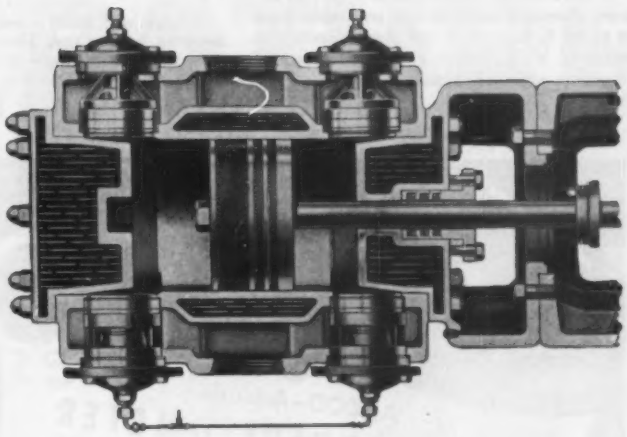
Explosion of undetermined origin at Shell Chemical's Deer Park, Texas, plant **ripped out walls of a products development unit.** Steel structure of three-story building was not damaged, nor was anyone injured. Shell officials say a batch process for making adhesive was underway in building.

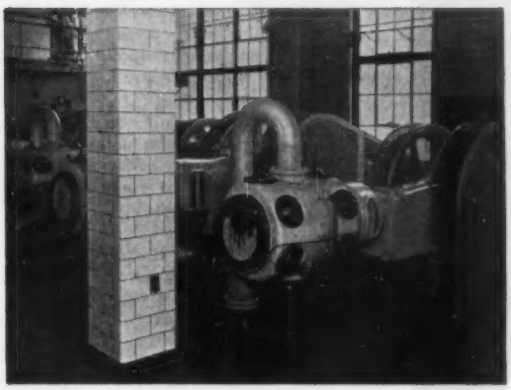
Esso Standard has **discontinued its paraffin press operations** at Baton Rouge. Func-

A dependable supply of oil-free air or gas

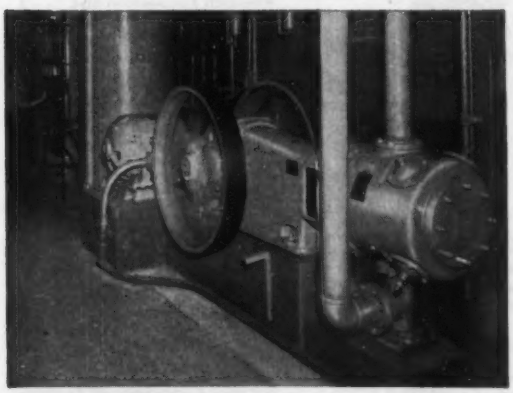
Graphitic-carbon wearing rings and pressure rings prevent metallic contact between the piston and cylinder bore—no oil is used anywhere in the compression cylinder or on the piston rod.

NL Channel Valves are designed specifically for non-lubricated service. Carbon guides protect channel ends and special Teflon strips protect channel interiors and spring ends from metal-to-metal rubbing and wear.





Installed in a large brewery in 1933, this Ingersoll-Rand ES-NL compressor was the first unit ever built with non-lubricated cylinders. It is still in daily service, providing the clean, oil-free compressed air which is vital to product purity. Three other ES-NL compressors, installed since then, are shown in the background.



One of four ES compressors with NL cylinders, supplying oil-free air in the manufacture of super-precision instruments and aircraft ball bearings.

with Ingersoll-Rand ES-NL compressors

In process and manufacturing plants all over the world, the problem of oil contamination in compressed air and gases has been successfully solved by the application of Ingersoll-Rand ES-NL compressors.

The unique NL cylinder design provides compression without oil lubrication—through the use of graphitic-carbon wearing and pressure rings. The ability of these compressors to deliver clean, oil-free air and gas, in continuous, heavy-duty service, has been thoroughly proved in every field of application.

If you have an application where oil-lubricated compressor cylinders cannot be used, ask your Ingersoll-Rand representative about the ES-NL compressor, sizes 5 to 150 horsepower—other Ingersoll-Rand NL compressors to 1000 hp.

Ingersoll-Rand

I-422 **11 Broadway, New York 4, N. Y.**

COMPRESSORS • CONDENSERS • AIR & ELECTRIC TOOLS • PUMPS • ROCK DRILLS • GAS & DIESEL ENGINES

What's Happening. . .

tion formerly performed by paraffin presses, in use since 1911, will now be handled by expansion of solvent dewaxing unit in operation since 1948.

National Bureau of Standards has **extended temperature range in which pH standards are certified.** Former pH scale was determined only between 0 and 60 C.; **now standard samples are available from 0 to 95 C.** Extension was made possible by work of V. E. Bower and R. G. Bates of Bureau's physical chemistry lab.

Conoco's idle Lance Creek, Wyo., gasoline plant has been sold to Mid-States Pipe and Supply Co. Modern and complete plant was designed to process about 25 million cubic feet of gas per day. Tulas Consulting Engineer, C. J. Smith will handle sales and liquidation of plant equipment and material.

British unit of Petrofina group has changed its name from Fina Petroleum Products, Ltd., to Petrofina (Gt. Britain) Ltd.

Texaco will build a **new 16-story office building in Houston.** Present building and new one will be ample to accommodate all employes, now located in other buildings.

It's been estimated that **"little cars"** which will account for 7 to 8 percent of service station sales next year, **will account for possibly 50 percent in the 1960's.** This will require a complete shift in service station inventory to handle "littler" accessories. Also, these cars tend to retard premium gasoline sales.

Northern Indiana Public Service Co., Hammond, Ind., will begin **construction early next year on 300,000 barrel LPG storage cavern** in solid rock as deep as 350 feet.

Motor vehicle registration in the U. S. this year will reach all-time high of 67,231,000—up about 2 million from 1956. Licensed drivers will also hit new peak of 77,869,000.

Esso Standard of New York has inaugurated a **12-hour course in creative thinking** for employes. **Purpose:** to stimulate employe contributions to the company's suggestion plan.

Petroleum refiners' sales volume for the first six months of 1957 **was up 15 percent over similar period last year;** after-taxes profits were up 8 percent.

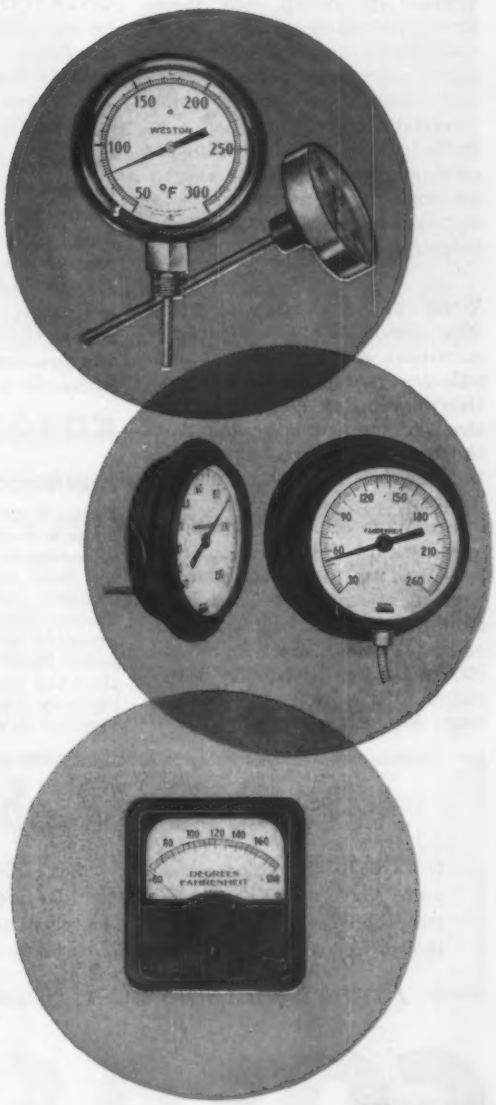
During 1956, 9,590,234 gallons of brake fluid were compounded. Of that amount, **1,625,306 gallons failed to meet SAE or government specifications.**

ARCCO
ARCCO-Anubis
LIQUID GRAVITOMETER
For PIPELINES, REFINERIES, GASOLINE PLANTS
NOW 19 MODELS
MODEL R
This ruggedly built instrument of laboratory accuracy is ideal for quick checking and for continuous recording of Specific Gravity of liquids under line pressure. Changes in Specific Gravity of sample are recorded with a very minimum of time lag. Foreign liquids and gases are automatically purged from sample. No moving joints or stuffing boxes to cause friction or leakage. Temperature corrected, this precision instrument is adaptable to high pressures. Hundreds are in daily use in plants and refineries of major companies. Available in 19 Models for Recording, Signalling, Transmitting and Controlling. Send for Bulletin 111R-3.
AMERICAN RECORDING CHART CO.
3113 E. 11th St. • Los Angeles 23, Calif.
AVAILABLE FOR EARLY DELIVERY
Send for Bulletin No. 111R3

MEETINGS CALENDAR

NOV.	
12–14	National Association of Corrosion Engineers, Northeast Region Fall Meeting, Penn-Sheraton Hotel, Pittsburgh.
13–14	Air Pollution Conference, Armour Research Foundation and Midwest Air Pollution Prevention Association, Chicago.
13–16	National Association of Corrosion Engineers, Miami Section, Key Biscayne Hotel, Key Biscayne, Fla.
22	Natural Gasoline Association of America, Panhandle Plains Regional Meeting, Herring Hotel, Amarillo.
DEC.	
1– 6	American Society of Mechanical Engineers Annual Meeting Statler Hotel, New York.
2	American Society of Mechanical Engineers, Annual Meeting, Hotel Statler, New York.
5– 7	American Chemical Society, Southwest Regional Meeting, Tulsa.
8–11	American Institute of Chemical Engineers Annual Meeting Conrad Hilton Hotel, Chicago.
1958	
FEB.	
3– 4	Instrument Society of America National Conference on Progress and Trends in Chemical and Petroleum Instrumentation, Wilmington, Delaware.
10–14	American Society for Testing Materials, Committee Week, Hotel Statler, St. Louis, Mo.
MAR.	
17–21	National Association of Corrosion Engineers, National Meeting, Civic Auditoriou, San Francisco.
APRIL	
15–17	Southwestern Gas Measurement Short Course.
20–23	American Institute of Chemical Engineers, Montreal, Canada.

3 WAYS TO MEASURE TEMPERATURE



bi-metal THERMOMETERS

for industrial and "built-in" needs

Overwhelmingly preferred because of their all-metal ruggedness, stability and long life. In heavy duty types, straight and angle forms, 6″ and 5″ dia heads – industrial types, angle form, 3″ and 2″ heads; stainless steel stems, lengths from 2½″ to 24″. Ranges low as –100 F to high as 1000 F; accuracy 1% of range.

filled system THERMOMETERS

for remote readings–alarms

Available with mercury, liquid, gas filled, or vapor pressure actuations in 5″, 6″ and 8″ dial sizes – for wall or flush mounting. Models to indicate as low as –325 F or as high as 1000 F. Available with adjustable electrical contact and index pointer for signal or alarm needs.

electrical resistance THERMOMETERS

for remote and multiple readings

Resistor bulb permits remote temperature readings – and by use of several bulbs, several different remote temperature measurements can be made using a selector switch. Accuracy 1% of full scale. Ranges low as –100 to high as 500 F.

For literature write . . . Weston Electrical Instrument Corp., Newark 12, N. J.

WESTON THERMOMETERS

For more data on advertised products, use Readers' Service Cards, last page.

NOW you can enter against pressure for Corrosion Control

Safely . . . Economically!

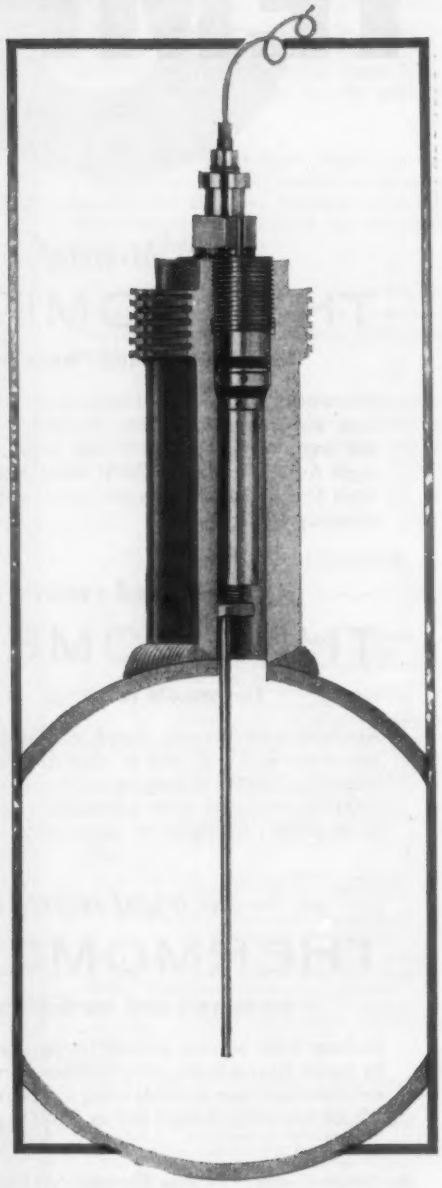
Without interfering with operations, you can now go into vessels and pipe lines on stream to investigate corrosion, its rate, cause and effects. This is possible when COSASCO *Access* Nipples are installed at strategic locations as pressure-proof ports for the insertion of coupons and to secure data with water samplers, thermocouples and hydrogen probes.

While coupons continuously provide means of recording rate of corrosion, samplers permit periodic analysis of possible causes, thermocouples contribute desired temperature readings and the hydrogen probe helps to determine the concentration of free hydrogen present. With such information at hand, intelligent application of measures for control can be made to prolong equipment service life, reduce or eliminate product pollution and, consequently, protect important capital investment. In many cases, product quality can be more easily maintained.

COSASCO *Access* Nipples may be installed at any time: either during shutdown or, with a COSASCO Hot Tapping Assembly, while vessel or line is under full operating pressure.

The *Access* Nipples have removable low-carbon type 303-304 stainless steel plugs. Special plugs for the samplers, thermocouples, and hydrogen probes are also of this highly corrosion-resistant material. COSASCO *Access* Nipples are applicable to any pressure or storage system, hydraulic or gaseous.

COSASCO



THERMOCOUPLE ACCESS PLUG

Here a Thermocouple Plug is shown in place in an *Access* Nipple welded to a tapped pipe line. The closed-end tube extending into the line contains the iron-constantine wire inserted through the plug. The entire assembly is completely pressure-proof. Plugs fitted for water sampling and probing for hydrogen are basically similar. Details will be supplied on request.

What's your problem?

If it's an entry-against-pressure problem, COSASCO engineers invite you to submit details. Send blueprints or drawings to depict the problem, and the COSASCO solution will be supplied *without charge*. You will be under no obligation whatever for this service.

Protect equipment . . . Save product

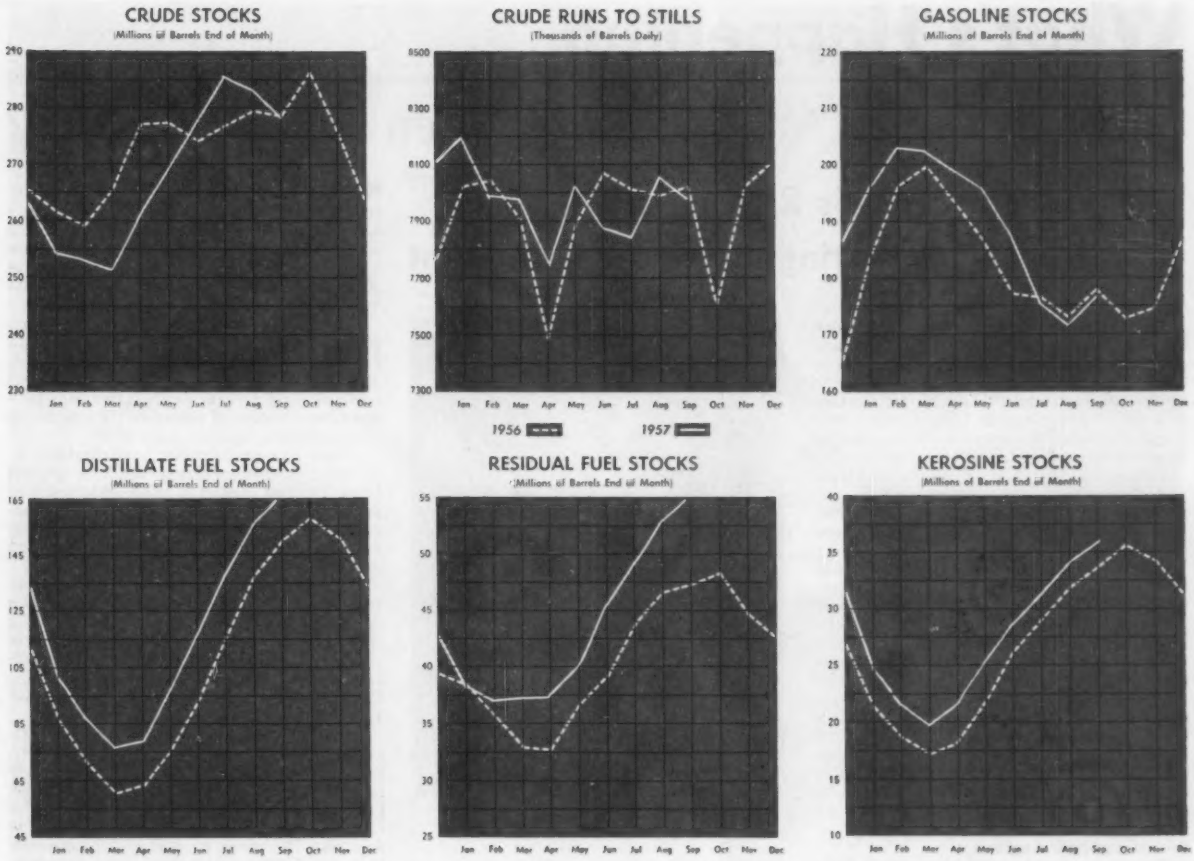
COSASCO

Division of
Perfect Circle Corporation

11655 McBean Drive, El Monte, California

Export Office: 3631 Atlantic Avenue, Long Beach 7, California

For more data on advertised products, use Readers' Service Cards, last page.


CRUDE STOCKS
(Millions of Barrels End of Month)
CRUDE RUNS TO STILLS
(Thousands of Barrels Daily)
GASOLINE STOCKS
(Millions of Barrels End of Month)
DISTILLATE FUEL STOCKS
(Millions of Barrels End of Month)
RESIDUAL FUEL STOCKS
(Millions of Barrels End of Month)
KEROSINE STOCKS
(Millions of Barrels End of Month)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1956
1957

Taking Stock

Cecil W. Smith
Economics Editor

- **Fuel oil stocks at all-time peaks**
- **Gasoline inventories start build-up**
- **Refinery runs continue to be sliced**

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1955:													
September	6,731	7,483	256,269	3,784	150,194	279	36,361	1,621	143,248	1,061	46,267	829	1,218
October	6,837	7,465	267,346	3,827	153,103	309	36,705	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	341	33,283	1,680	141,806	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	395	26,770	1,765	111,333	1,286	39,174	884	1,502
1956:													
January	7,199	8,023	261,592	3,927	183,905	385	21,310	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	385	18,712	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	342	17,215	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	299	18,227	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	292	21,883	1,667	75,928	1,149	36,607	938	1,416
June	7,100	8,071	274,491	3,976	177,076	290	26,111	1,755	93,758	1,098	39,073	987	1,426
July	7,090	8,014	277,008	3,975	176,536	296	28,990	1,767	115,787	1,066	43,958	1,084	1,463
August	7,195	7,995	279,944	4,037	172,939	313	31,826	1,839	137,905	1,091	46,617	1,001	1,399
September	7,054	8,024	278,791	3,991	177,974	329	33,588	1,845	150,411	1,062	47,342	1,043	1,452
October	6,966	7,608	286,560	3,773	172,798	356	35,667	1,772	158,871	1,082	48,400	1,004	1,541
November	7,139	8,031	275,995	3,913	174,808	384	34,329	1,841	151,517	1,182	44,590	871	1,362
December	7,377	8,141	266,014	4,039	187,271	379	31,420	1,981	133,981	1,288	44,491	873	1,471
1957:													
January	7,480	8,274	256,669	3,991	197,702	367	24,019	2,118	100,572	1,322	38,403	805	1,425
February	7,682	8,088	256,344	3,864	205,270	353	21,013	2,035	85,105	1,270	31,201	780	1,430
March	7,717	8,047	254,911	3,826	206,716	332	20,223	1,861	76,245	1,205	37,371	836	1,464
April	7,541	7,740	265,796	3,770	201,407	284	21,512	1,764	78,743	1,132	37,429	906	1,542
May	7,442	7,992	275,963	3,900	195,094	272	25,545	1,789	98,135	1,103	41,125	1,042	1,558
June	7,107	7,867	284,312	3,984	190,063	254	28,872	1,773	117,364	1,101	45,572	1,147	1,606
July	6,873	7,852	288,241	3,887	177,868	249	31,713	1,750	138,359	1,090	49,621	1,220	1,654
August	6,799	8,077	283,974	3,997	172,217	270	34,318	1,793	156,307	1,102	52,914	1,191	1,666
September	6,822	7,970	278,415	4,070	177,403	276	36,013	1,769	170,423	1,126	57,937	1,045	1,475
Week Ended:													
10-25-57	6,766	7,649	284,878*	3,907	179,288	287	35,486	1,732	174,977	997	59,465	1,001	1,550
10-26-56	7,003	7,670	281,557*	3,704	171,985	383	34,518	1,770	157,268	1,106	47,493	1,181	1,547

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels. * Stocks of previous week.

What's Happening . . .

. . . *Among Men* in the Industry

Dr. Warren K. Lewis Receives 1957 API Gold Medal for Distinguished Achievement

Dr. Warren K. Lewis, an educator known internationally as a research scientist, and as the father of modern chemical engineering, has been presented the American Petroleum Institute's "Gold Medal for Distinguished Achievement." Dr. Lewis is professor emeritus of chemical engineering at Massachusetts Institute of Technology.

Formal presentation of the Gold Medal and the scroll which accompanies it took place at the first general session November 11, in the grand ballroom of the Conrad Hilton Hotel.

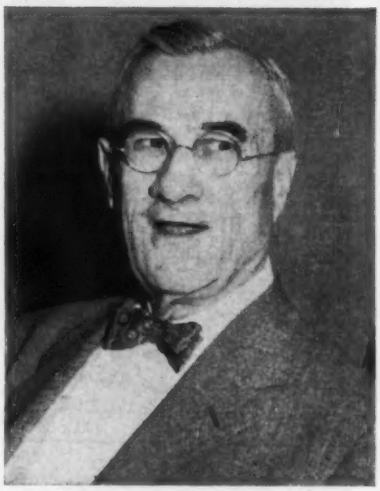
The API Gold Medal is regarded as one of the top industrial citations in the country. It is presented to some outstanding American, not necessarily an oil man, who has contributed substantially to the advancement of mankind through the petroleum industry.

High honors are not new to Dr. Lewis, for he already has been awarded three honorary doctorates as well as the Perkin Medal of the Society of Chemical Industry, the Priestly Medal of the American Chemical Society, the Gold Medal of the American Institute of Chemists, and the New England Award of the Engineering Societies of New England.

An outstanding teacher for nearly a half-century, he also is an international leader in petroleum research, and as an engineer whose imagination and research have led to great advances in the industrial fields of rubber, leather, cellulose, and amorphous materials in general.

He is credited with many contributions to the oil business. He developed or played major roles in the perfection of efficient methods of fractionation in refining; of the solvent recovery systems; of vacuum distillation of lubricating oils, and of fluid catalytic cracking.

His more fundamental studies have led to significant discoveries on the structure of liquids, the flow of heat and liquids, and in such fields as the gasification of coal and the synthesis of hydrocarbons.



Dr. Warren K. Lewis

Dr. Lewis is regarded as the man who acquainted the petroleum industry with chemical engineering, and made it chemical engineering-minded. In the years of his service as an educator and scientist, he personally acquired more than 60 patents applying to petroleum.

The API Gold Medal was inaugurated in 1946, and awards have been made annually except for the years 1952 and 1955.

Shown are the five recipients of the CNGA Service Awards of Merit which were presented at the organization's annual fall meeting held recently in Los Angeles. From left to right are Paul Armstrong, Union Steam Pump Sales Co.; Clarence Gotterba, Richfield Oil Corp.; Harold Dresser, Petrocon Engineering Co.; C. L. Hutchings, Tidewater Oil Co.; and Don E. McFaddin, Union Oil Co. of California.

R. C. Alden, chairman of Phillips Petroleum Co.'s research planning board and a petroleum science pioneer, has chosen early retirement, according to K. S. Adams, chairman, and Paul Endacott, president. Alden's retirement became effective November 1.

A graduate of Lehigh University, Alden joined Phillips in 1925 when the company's research department was being organized. In 1930 he became assistant director of research and three years later was promoted to director of research. He has served in his present capacity since 1950.

Alden has made major contributions to many of the developments which have come from Phillips' research laboratories and pilot plants. He has written numerous articles for scientific and trade publications, and many of his inventions have resulted in patents.

In 1937 Alden was the first recipient of the Hanlon Award of the Natural Gasoline Association of America for 'meritorious service to the natural gasoline industry.' He was the 1956 guest of honor of the American Society for Testing Materials (ASTM), Committee D-2 on Petroleum Products and Lubricants.

Alden has served on numerous industry and government committees concerned with technical activities of the oil industry. He is a director of ASTM, the University of Oklahoma Research Institute, and of the Coordinating Research Council, Inc.; is first vice chairman of ASTM's Committee D-2; and holds memberships in many scientific societies and trade associations.

Dr. Hugh Stott Taylor has been awarded The Franklin Medal, award of The Franklin Institute of the State of Pennsylvania. Dr. Taylor is dean of the graduate school of Princeton University, and also is the David B. Jones professor of chemistry at Princeton. Formal presentation of the award was made at the Institute's annual Medal Day ceremonies.

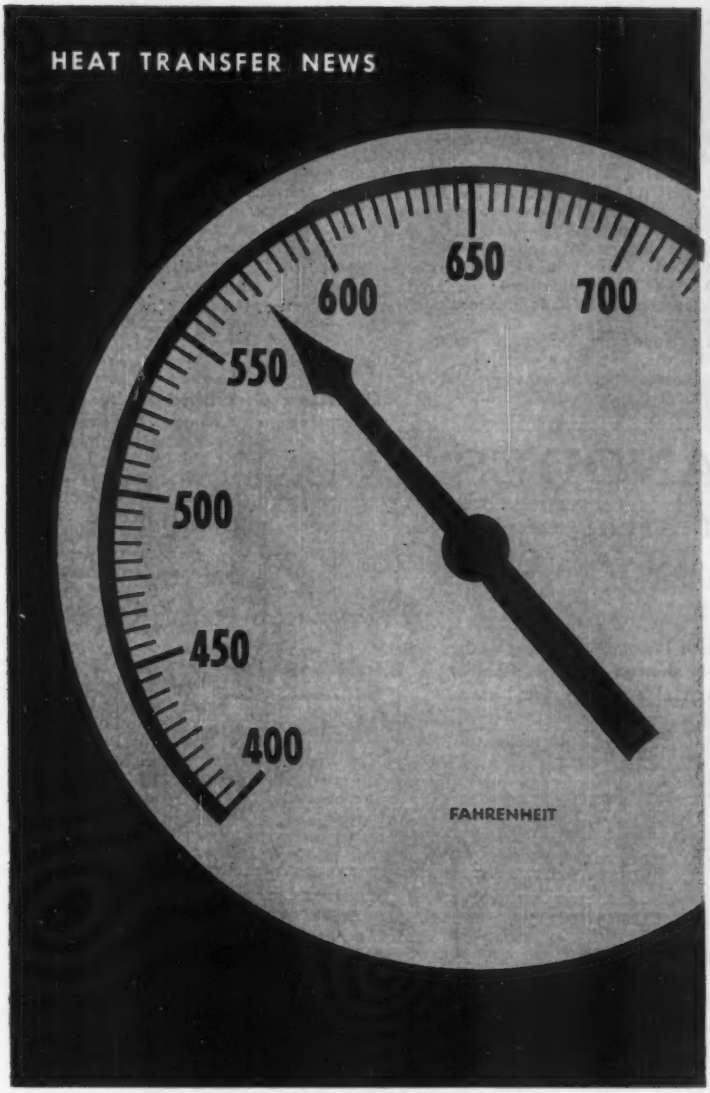
Dr. Taylor has been elected recipient of The Franklin Medal "In recognition of his many notable contributions to the science of physical chemistry, particularly his development of the widely significant theory of heterogeneous catalysis, and his eminent achievement as author, editor and teacher."

Hugh W. Howard, who received his M.S. degree in chemical engineering from Cornell University in 1945, has joined the engineering department planning section of Monsanto Chemical Co.'s Plastics division, Springfield, Mass., after 20 years service with the U. S. Navy where he attained the rank of Commander.

John F. Johnson has been named a section head in the chemicals research division of Esso Research and Engineering Co. He had been in the firm's chemicals development division.

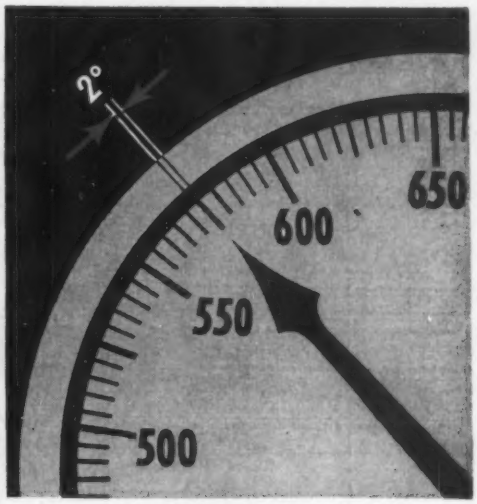
Dr. Johnson, who holds a Ph.D. in chemical engineering from the University of Minnesota has been with Esso Research since 1948. He also earned a B.S. degree in the same field at Minnesota.

During World War II, chemical engi-



Continuous operating temperature up to 600° F.

Boiling range 652° to 725° F.—assures liquid at all times.



Pin-point control within 2° F.

Write Monsanto for sources of heating systems using Aroclor 1248 . . . a non-pressurized, liquid-phase, heat-transfer fluid

Aroclor 1248 is a new kind of heat-transfer fluid that's fire-resistant and operates at atmospheric pressure.

The Equipment . . . Capacities can range from small portable units, usually electrically heated, to large gas- or oil-fired units generating from 250,000 to over 10,000,000 B.T.U.'s per hour. Circuits are closed, forced circulation. Compact design saves space, minimizes installation and maintenance costs.

The Fluid . . . Aroclor 1248 is a highly stable chlorinated polyphenyl; does not support combustion up to its boiling range 652° to 725° F.; has autogenous ignition temperature of extremely high 1299° F.; is non-corrosive. Aroclor 1248 operates in most systems four to seven years without replacement.

Monsanto will send you a list of designers and manufacturers of Aroclor 1248 equipment. Write today.

AROCLOR: Reg. U. S. Pat. Off.

Organic Chemicals Division
MONSANTO CHEMICAL COMPANY
Dept. IF-72, St. Louis 1, Missouri

MONSANTO

WHERE CREATIVE CHEMISTRY WORKS WONDERS FOR YOU

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Men in the Industry . . .

neer Johnson worked for more than a year testing propellants for artillery rockets at a government laboratory in Maryland. He is a member of the American Institute of Chemical Engineers and the American Chemical Society.

James F. Allen has been appointed manager of the Refinery Chemicals department of American Cyanamide Co.'s Industrial Chemicals division.

Allen, formerly assistant manager of the department, joined Cyanamide in 1950 and has served in a variety of sales and technical posts in the Industrial Chemicals division.

Roscoe F. Stahl, associate director of research at Texas City, for American Oil Co., has been named assistant manager of manufacturing economics with headquarters in New York. He will report to **C. F. Feuchter,** formerly manager of planning, who assumes the new title of manager of manufacturing economics.

H. K. Wheeler, assistant plant manager at the El Dorado, Ark., refinery, has been promoted to the newly created position of director of planning in the Research and Development department, and also will be located in New York. Wheeler will report to **Dr. A. A. O'Kelly,** director of research and development, who has headquarters in Texas City.

Guy L. Honeycutt, operating superintendent at the Yorktown, Va., refinery, has been named assistant manager at El Dorado, succeeding Wheeler.

C. W. Shelley is the new training director at Magnolia Petroleum Co.'s refinery in Beaumont. Shelley will direct the planning and coordination of training activities throughout the Refining Division.

He replaces **W. W. McMullen, Jr.,** named earlier to Socony Mobil Oil Co.'s Employee Relations staff in New York.

The training director position is in the refinery's Employee Relations department. Shelley has been a member of that department since November, 1952, when he moved from a process engineer job in the Technical Department to the post of training assistant. For the past year he has been engaged in college relations work.

Dr. Alex G. Oblad has been elected vice president in charge of Research and Development for The M. W. Kellogg Co., New York, a subsidiary of Pullman Inc.

Oblad

Dr. Oblad has devoted his professional career to petroleum and petrochemical research and development. Prior to joining M. W. Kellogg, he was vice president in charge of research and development and on the board of directors, Houdry Process Corp., Philadelphia. His responsibilities at the same time joined him with the expansion of the Catalytic Construction Co., a Houdry subsidiary. Earlier in his career, Dr. Oblad was associated with the Texas Research Foundation, the Magnolia Petroleum Co. and The Standard Oil Co. (Indiana).

Dr. Oblad holds a Ph.D. degree in physical chemistry from Purdue University and B.A. and M.A. degrees in chemistry from the University of Utah.

Milo M. Brisco was elected executive vice-president of International Petroleum Co., Ltd., at a meeting held by the board of directors at the company's executive office in Coral Gables, Fla.

Brisco joined an International subsidiary in Colombia in 1935 and held various managerial positions until 1953, when he was named general manager of the company's operations in Peru. In 1955 he returned to Colombia as International's executive representative in charge of all company operations. Brisco was elected to the board of directors last May.

J. H. Smith, Ponca City, Okla, has been promoted to manager of manufacturing for Continental Oil Co.'s southern and southwestern regions. Formerly chief process engineer in Conoco's manufacturing department, he succeeds **H. R. Wall,** Houston, who recently was promoted to general manager of transportation and supplies.

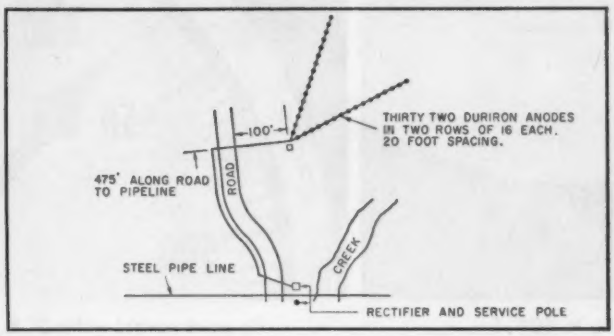
It was announced at the same time that **Daniel F. Cameron,** Ponco City, will succeed Smith as chief process engineer in the company's manufacturing department. He will continue to make his headquarters at Ponca City.

A native of Indiana, Smith received his B.S. degree in chemical engineering in 1940 from Purdue University and joined Conoco as a technologist three years later at Ponca City. He has been

32 DURIRON® ANODES

protect 11,000 feet of steel water line without backfill

The Problem: An isolated section of 11,000 feet of steel water line needed cathodic protection. Tests showed current requirements to be 40 amps., but replacement of adjacent wood stave lines called for extra capacity. Ground was a peat bog with water table standing at 6 inches below surface, making backfill methods impossible.


100'
THIRTY TWO DURIRON ANODES IN TWO ROWS OF 16 EACH. 20 FOOT SPACING.
475' ALONG ROAD TO PIPELINE
ROAD
CREEK
STEEL PIPE LINE
RECTIFIER AND SERVICE POLE

The Installation: 32 Duriron Anodes (2" x 60") were installed without backfill, by digging through the dry surface and then pushing anodes down until the tops were 3 feet below surface. Anodes were installed 20 feet apart, in two rows, with a calculated resistance of one ohm, based on previous experience with similar installations. While conventional backfill columns would have reduced the number of anodes necessary, the use of bare anodes constituted a major saving in cost.

The Performance: The anode bed is discharging 60 amps. at a terminal voltage of 59 volts. The entire line section is under protection, the minimum potential being 1.18 volts. This affords ample margin to handle prospective additions to the line. Agreement between actual and calculated anode resistance is quite close.

Action: For further information on this particular installation or for technical assistance on other Duriron impressed current anode installations, write:

DURCO CORROSION RESISTING ALLOYS & EQUIPMENT

THE DURIRON COMPANY, INC.
DAYTON 1, OHIO

For more data on advertised products, use Readers' Service Cards, last page.

for plastics and resins:

90 plants

20 products

1 builder

Blaw-Knox, pioneer in the industry, sets the pace in designing and building plants for polymer and resinous compound production.

Blaw-Knox has led for twenty-five years in plant development for products ranging from condensation polymers such as alkyds and polyesters to addition polymers including synthetic rubber, polyvinyl chloride and polyvinyl acetate. Blaw-Knox construction parallels the mushrooming growth of the industry.

Blaw-Knox unexcelled know-how will pay off on your next project. A complete service is available—from preliminary planning to initial operation. Contact Blaw-Knox for details.

BLAW-KNOX

BLAW-KNOX COMPANY

Chemical Plants Division • Pittsburgh 22, Pa. • Chicago 1, Ill.

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See our exhibit in Booth 581—Chemical Show, New York—December 2 to 6

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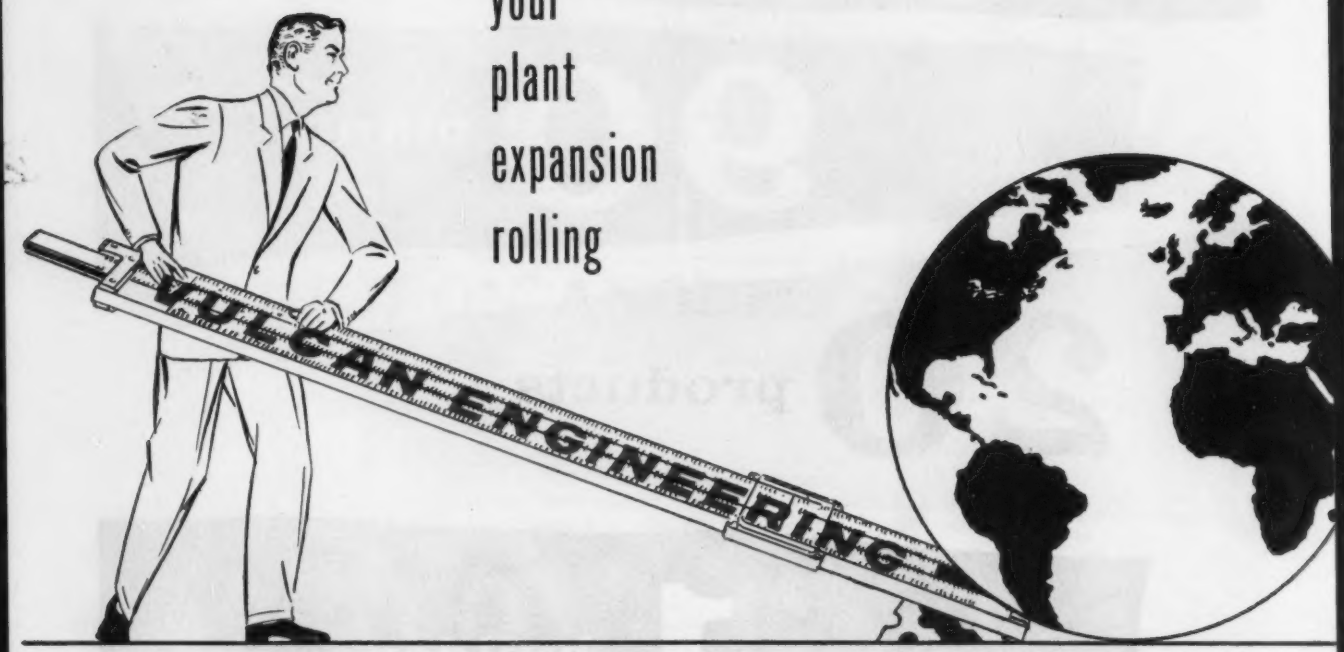
a lever to get your plant expansion rolling



. . . multiplies your own capacity for:

Early completion of erection
Minimized plant investment
Quick startup
Reliable, low cost operation

PROCESS COMPARISONS
Organic Synthesis . . . Petrochemicals . . . Waste Disposal . . . Absorption . . . Extraction . . . Distillation.

COST SURVEYS

JOB STANDARDS

PROJECT MANAGEMENT
Coordination to maintain drawing and procurement budgets and schedules . . . Periodic reports to Owner.

DESIGN AND DRAFTING
Equipment layout . . . Piping, structural and electrical design . . . Construction drawings . . . Bills of Material . . . Vendor drawing check.

PROCUREMENT
Careful analysis of competitive bids . . . Sound purchasing . . . Alert expediting . . . Thorough inspection.

CONSTRUCTION MANAGEMENT

OPERATOR TRAINING

VULCAN ENGINEERING DIVISION

VULCAN–Cincinnati, Inc. *General Offices and Plant,* CINCINNATI 2, OHIO

HOUSTON BOSTON CHARLOTTE, N. C. ST. LOUIS DENVER SAN FRANCISCO

VULCAN ENGINEERING DIVISION • VULCAN MANUFACTURING DIVISION • VULCAN CONSTRUCTION DIVISION

Men in the Industry . . .

chief process engineer in the company's manufacturing department since 1948.

Cameron joined Conoco's manufacturing department at Ponca City in 1951. He was promoted to senior process engineer early in 1955 and became assistant chief process engineer later that year.

Charles H. Atwood has been appointed president of Union Carbide Caribe, Inc., a subsidiary of Union Carbide Corp. Union Carbide Caribe will operate the new petrochemicals plant under construction near Ponce, Puerto Rico, which will produce ethylene oxide and derivatives.

Atwood joined Union Carbide in 1927 at the laboratories of Union Carbide Chemicals Co., division of the corporation, in South Charleston, W. Va. He was made superintendent of the plant at Institute, W. Va., in 1945. He held this latter position until his recent transfer to Union Carbide Caribe.

Atwood graduated from the University of Pittsburgh with a B.S. degree in chemical engineering in 1927.

T. Q. Eliot has joined the Technical division of Texas Butadiene & Chemical Corp., Houston, where he will assist in process design, economics and new project evaluation.

Eliot

Eliot was formerly process supervisor at Amoco Chemical Corp.'s Brownsville plant, recently closed. He had been with Standard Oil Co. (Indiana) affiliates since 1946, with responsibilities in the development of hydrocarbon synthesis process, and recovery and utilization of chemical products.

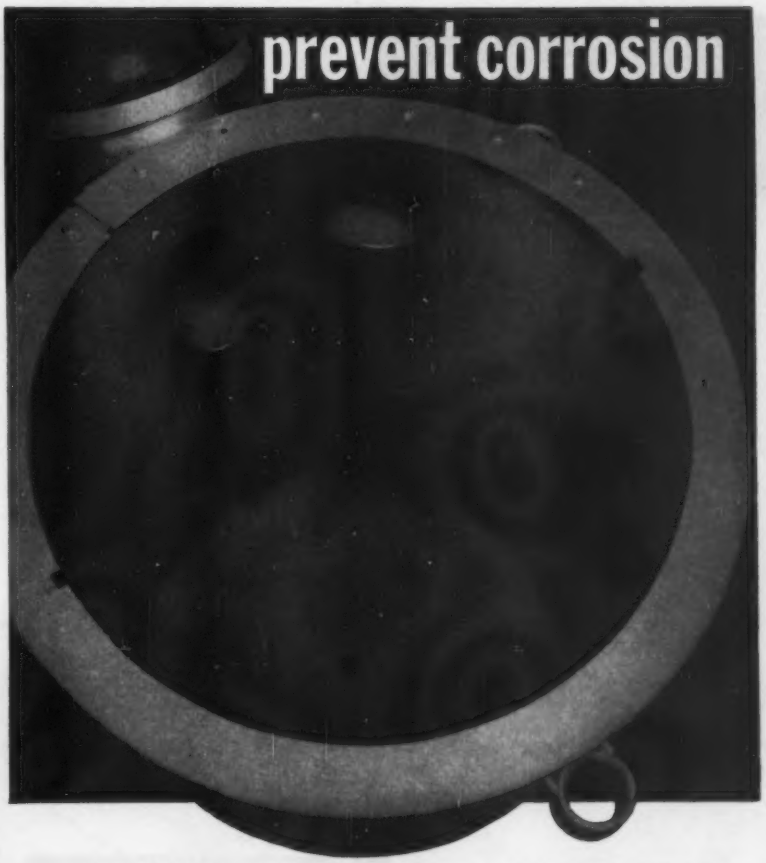
Prior to that time he was a research associate at M.I.T., having received his B.S. and M.S. degrees in chemical engineering there in 1942 and 1943, respectively.

William R. Blackstock has been named product development manager of the Chemical Division of Delhi-Taylor Oil Co., Corpus Christi, Texas. Blackstock will be in charge of market research and product development in petrochemicals.

Blackstock, a graduate of Carnegie Institute of Technology with a B.S. degree in chemical engineering, was recently associated with Pittsburgh Coke and Chemical Co. in sales, product development and market research. He is a member of the American Chemical Society and the Chemists' Club.

Dr. John Rehner, Jr., has been named a section head in the products research division of Esso Research and Engineering Co. Dr. Rehner received his Ph.D. in physical chemistry from the University of Minnesota. He was awarded his B.S. and M.S. degrees in chemical engineering from the University of Missouri. He has been with Esso Research nearly 17 years.

Kenneth C. Towe, president of American Cyanamid Co., has been elected to the newly created post of chairman of the board of directors. **Dr. Wilbur G. Malcolm,** formerly vice president for mar-



. . . with KEL-F LAMINATE linings

From a reactor pot to a tank truck—KEL-F* Laminate linings offer the way to make any ordinary equipment and piping extremely resistant to acids, alkalies, oxidants and solvents at temperatures up to 350°F—and at reasonable cost.

KEL-F Laminate, Garlock style No. 9574, is a durable, shatterproof, abrasion resistant, chemically inert fluorocarbon plastic, bonded to a glass-cloth backing for maximum adhesion. It is readily cemented over any contour and to any material of construction—metal, wood, concrete, etc. KEL-F being a thermoplastic resin, seams may be "welded", on the job by the thermal pulse technique, into a continuous chemically-impregnable lining.

CERTIFIED APPLICATORS—KEL-F Laminates are manufactured by the United States Gasket Company, pioneers and leaders in fluorocarbon plastics, and are available for installation by certified applicators.

Write for Bulletin AD-152.

UNITED STATES GASKET COMPANY
Camden 1, New Jersey

*Minn. Mining & Mfg. Co. Trademark

United States Gasket Plastics Division
OF THE GARLOCK PACKING COMPANY

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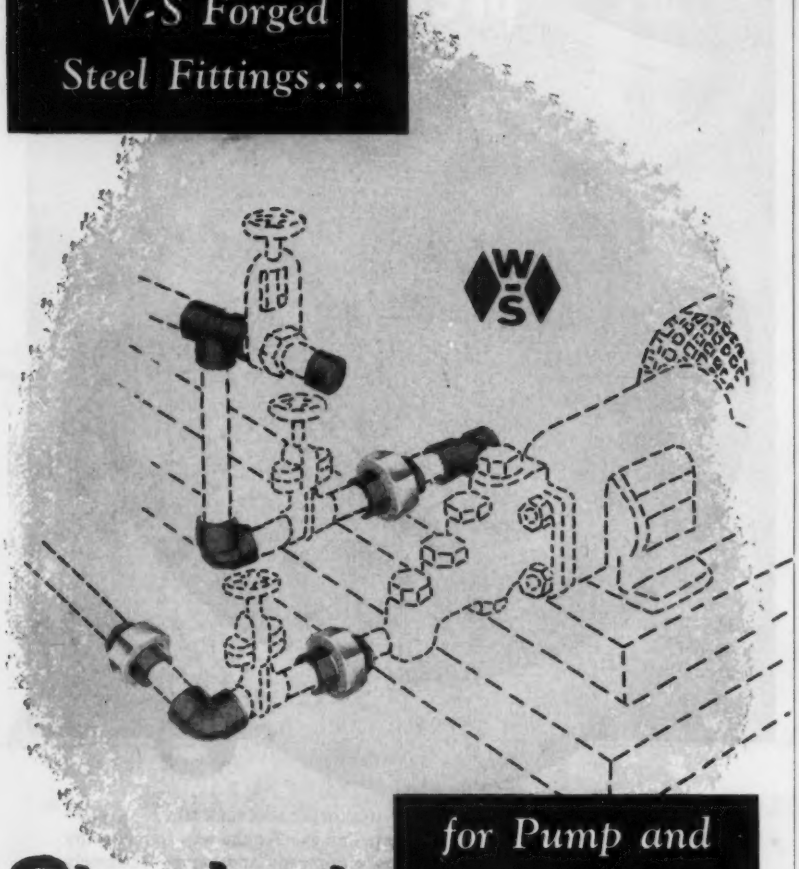
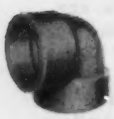
W-S Forged Steel Fittings...



Standouts for Pump and Compressor Piping



Whether the fluid be water, steam, oil, gas or chemical solutions ... if they are being pumped at high pressure, W-S Forged Steel Fittings will protect your pump or compressor piping. They are designed and manufactured to provide maximum resistance to pressure, shock and vibration.

W-S Fittings are drop forged from high strength carbon steel bars and precision machined on modern automatic equipment. A new blue synthetic coating protects the fittings from rust in storage and in service.

Don't forget ... you can order your W-S Fittings in handy packaged quantities.

For detailed information on our complete line of screw-end and socket-welding forged steel fittings, write to W-S Fittings Division, H. K. Porter Company, Inc., P.O. Box 95, Roselle, N. J.

H. K. PORTER COMPANY, INC.

W-S FITTINGS DIVISION

Men in the Industry ...

keting, was elected president and chief executive officer of the company. At the same meeting, **Kenneth H. Klipstein,** vice president, was elected to the board of directors, effective immediately.

William C. Bedoit, Jr. has been named manager, Market Development, of Jefferson Chemical Co.'s Commercial Development division. Dr. Bedoit will be responsible for all phases of market development.

Dr. Bedoit has been a senior research chemist at Jefferson's Austin, Texas, Research Laboratories since 1954.

Dr. John C. Hunt has been appointed a section head in the chemicals development division of Esso Research and Engineering Co. He had been a section head in an acting capacity for nearly a year.

Hunt started his Esso career in 1951, after having spent three years with General Aniline and Film Corp.

Dr. Hunt was graduated with a B.S. and an M.S. degree in chemical engineering from the University of Michigan.

L. S. Baldin, S. R. Fleming, and **W. O. Johnson** have been elected vice presidents of Ford, Bacon & Davis, engineers-constructors. Fleming was also elected vice president of Ford, Bacon & Davis Canada, Ltd., a wholly-owned subsidiary.

Baldin, who joined the firm in 1935, is in charge of valuation and report work carried on by the company. During World War II he served in an executive capacity at the Oak Ridge Atomic Energy Plant, where the firm managed part of these operations under contract with the U. S. Government.

Fleming, who also joined the organization in 1935, has had extensive experience in the design and construction of industrial plants and public utility systems. He is currently managing the company's Vancouver office.

Johnson, with the organization since 1941, directs the firm's industrial engineering activities. He has had long experience in the overall planning, layout and operations of a wide variety of manufacturing and process plants.

Fred M. Butler, Bartlesville, has been elected a director of Cities Service Oil Co. (Del.). Butler is manager of Cities Service Oil Co.'s industrial relations division and has been active in industrial and personnel relations work for the company since 1930. He was named industrial relations manager in 1941.

M. H. W. Dent, products manager in the transportation and supplies department has been named distribution manager for Shell Chemical.

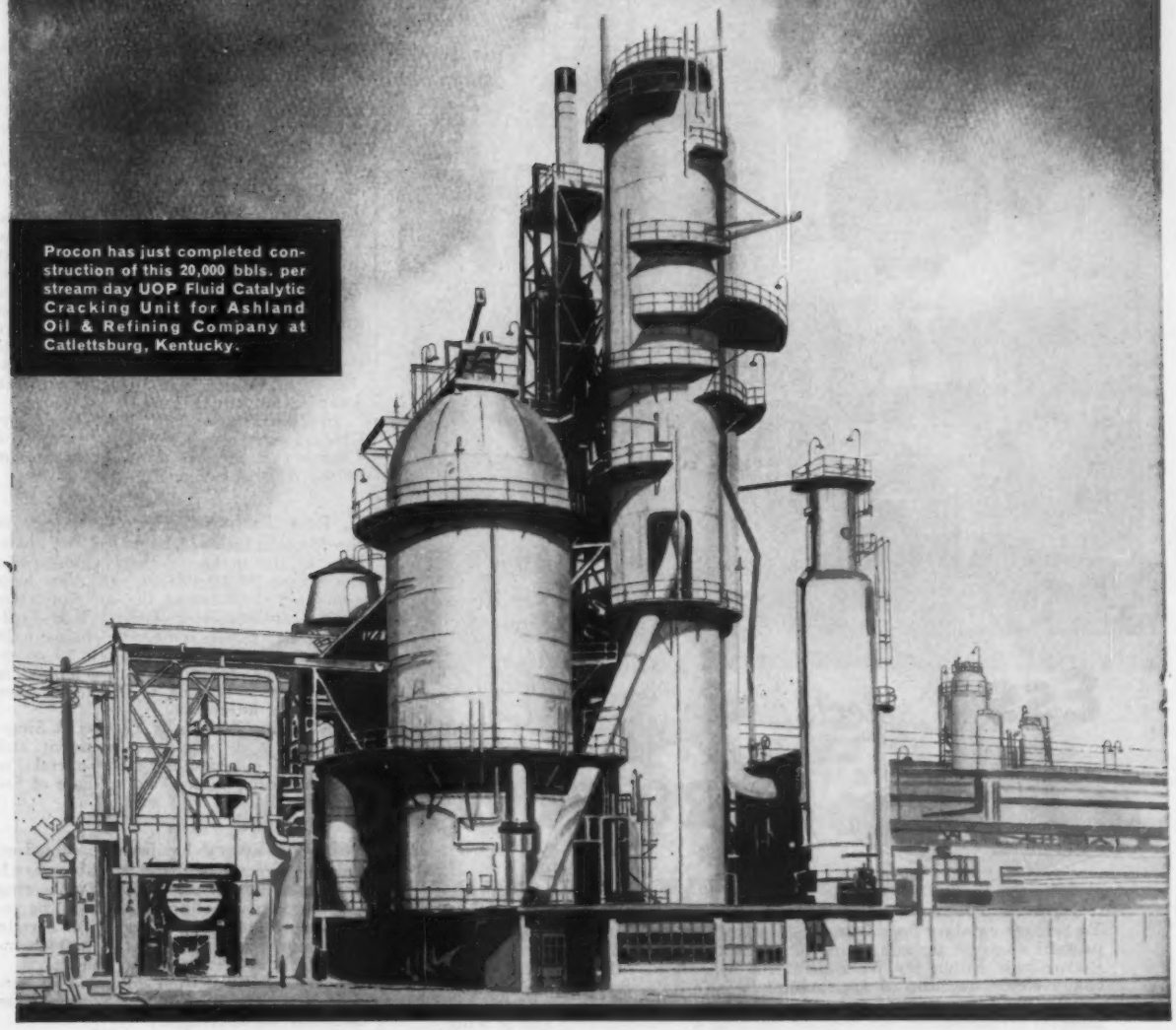
R. H. Tubman, assistant manager of manufacturing-operations, has been named products manager, replacing Dent.

Dent joined Shell in 1930, and became head marine clerk in the transportation and supplies organization at St. Louis in 1938. In 1946, he was appointed supervisor in the marine transportation department at New York, and in 1948 became assistant manager in the supplies department. He was named manager of the department in 1952.

Tubman started work for Shell in 1937 as a chemist at the Norco, La., refinery. He was appointed assistant manager of the alkylation department at the Wilmington,

For more data on advertised products, use Readers' Service Cards, last page.

True satisfaction in building comes only with the finished job



Procon has just completed construction of this 20,000 bbls. per stream day UOP Fluid Catalytic Cracking Unit for Ashland Oil & Refining Company at Catlettsburg, Kentucky.

Here at Procon we take a lot of satisfaction in all phases of our work as builders. Everything we do, from designing and engineering through each stage of construction, gives us that feeling of accomplishment which is so rewarding a part of any job well done.

We only get our fullest measure of satisfaction, though, when the job is finished, faithfully done to every requirement of specification and time.

Procon's experienced organization plans and builds refineries, petrochemical and chemical plants anywhere in the free world. You can count on any project you trust to Procon being completed to your true measure of satisfaction, too.

PROCON *Incorporated*

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PROCON (GREAT BRITAIN) LIMITED, LONDON, W. C. 2, ENGLAND
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WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL AND CHEMICAL INDUSTRIES

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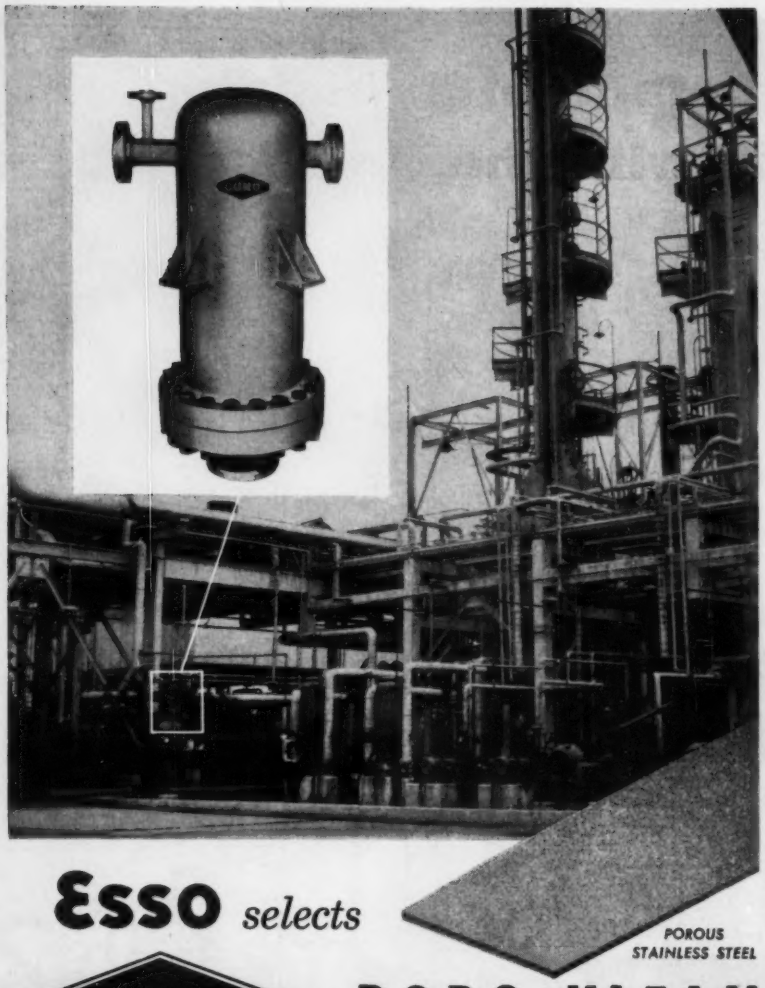


Esso *selects*

POROUS STAINLESS STEEL

CUNO

PORO-KLEAN
FILTER
for HYDROFINER

To remove catalyst fines from the Hydrofiner outlet stream – and thus prevent catalyst poisoning in the "reformer" – Esso selected a Cuno Poro-Klean Filter for its Baltimore, Maryland refinery. The fluid, heavy virgin naphtha of approximately 52.7 API, reaches the filter at 350°F. The Cuno Filter is a completely standard unit. Housing includes integral arrangements for in-place cleaning by backflushing and is built to meet A.S.M.E. Code requirements. For easy inspection, individual cartridges of sintered stainless steel are employed. The porous metal filter material manufactured by Cuno features a carefully controlled porosity that insures uniform fine filtration with complete removal of all catalyst particles.

Cuno Filters are now in service throughout the Petroleum Industry handling–

PRODUCT STREAMS · COMPRESSED AIR · PROCESS STREAMS
CHEMICALS · STEAM · SERVICE FLUIDS · ADDITIVES

WHATEVER YOUR FILTRATION PROBLEM . . . you can look to Cuno for the best possible unit to meet *your* specific needs. Remember ONLY CUNO offers you a truly complete line that includes all 5 types of filter media –

EDGE-TYPE • WIRE-WOUND • SCREEN • FIBER CARTRIDGE • POROUS METAL

CUNO **CUNO ENGINEERING CORPORATION**
34011 SOUTH VINE STREET, MERIDEN, CONN.
Designers and Manufacturers of Filters for Over Thirty Years

Men in the Industry . . .

Calif., refinery in 1950. In 1951, he became manager of the department, and subsequently served as assistant superintendent. He was named to his present position in 1956.

Dr. Herman S. Bloch, deputy director of refining research for Universal Oil Products Company, has been selected to receive the 1957 Honor Scroll of the Chicago chapter, American Institute of Chemists.

Bloch

A jury of six members of the Chicago chapter unanimously chose Dr. Bloch from a list of 10 nominees. He is the second man from UOP to receive the honor, the late Prof. Vladimir Ipatieff having been awarded the initial scroll in 1942.

Dr. Bloch is a past chairman of the Chicago chapter, American Institute of Chemists, as well as the Chicago section of the American Chemical Society.

R. Rea Jackson, general manager of the Manufacturing department and chairman of the manufacturing committee of the Socony Mobil Oil Co., Inc., has been appointed chairman of the company's coordination committee. He succeeds **Frederic R. Pratt,** who joined the company 26 years ago and assumed the post of chairman of the coordination committee in 1953. Pratt is retiring to devote his time to personal interests.

Succeeding Jackson is **Thomas P. Simpson,** who had been vice president and director of manufacturing of General Petroleum Corp., West Coast affiliate of Socony Mobil.

Robert F. Leary has been appointed an assistant director in the chemicals research division of Esso Research and Engineering Co. In his new position, Leary will be responsible for the administration of certain exploratory research work in petrochemicals. He had been a section head.

Leary graduated from Columbia University, New York, with a B.S. degree in chemical engineering.

Dr. A. A. O'Kelley, head of the Research and Development department of American Oil Co., has announced six recent promotions.

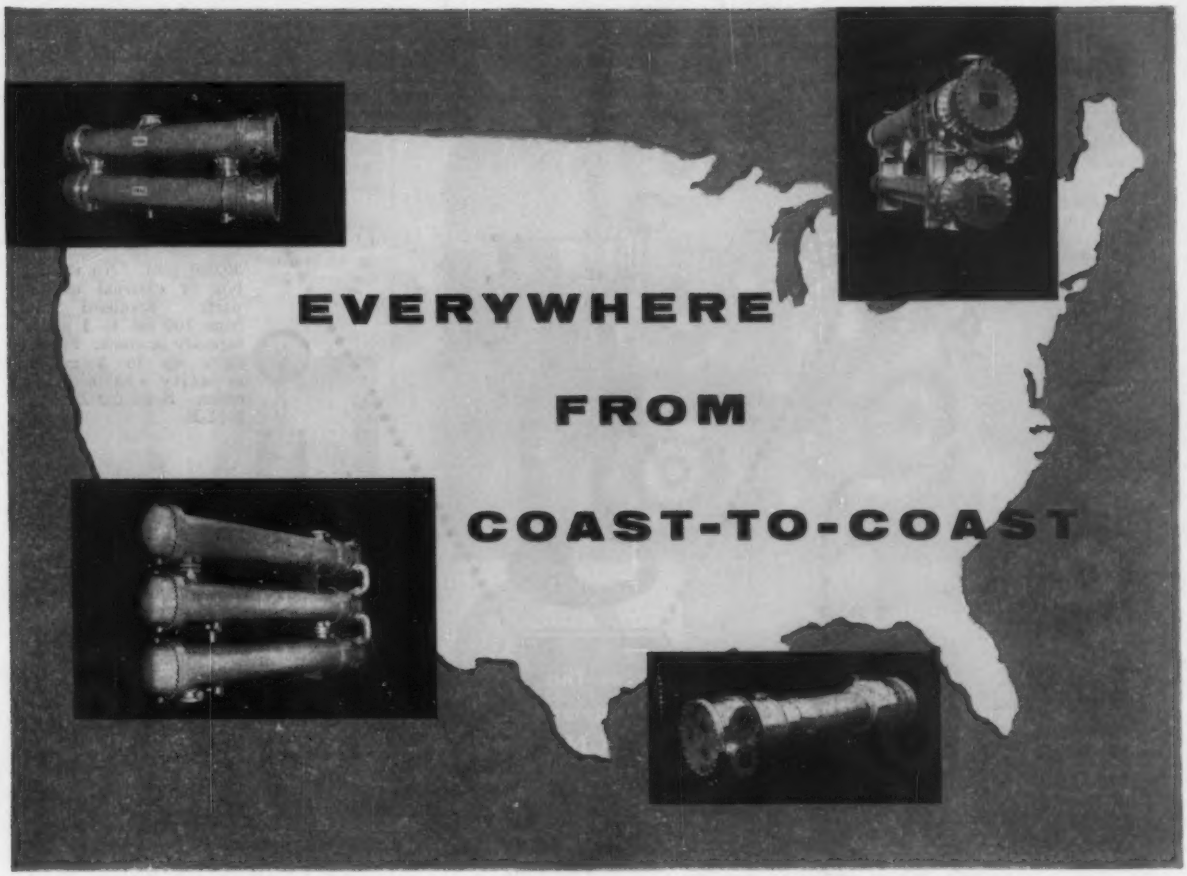
Those promoted include: **Harry K. Wheeler, Dr. J. F. Horner, Dr. H. D. Radford, W. F. Johnston, E. A. Siegman,** and **W. A. Davies.**

Wheeler, formerly of the company's Pan-Am Southern division, has been named to the newly created position of director of planning.

Dr. Horner has been named assistant director of Research and Development and will be in charge of the newly-formed Economics-Design division in Texas City.

Dr. Radford, appointed assistant director of the Research and Development department, will be in charge of the Process division.

Johnston was promoted to section head, development section. Prior to his recent



YUBA ENGINEERED HEAT EXCHANGERS

Complete facilities for the production of the finest heat exchangers are at your service at Yuba. With branch offices and representatives at every principal point throughout the country, Yuba is able to have a sales-engineer at your desk in a matter of hours to help you start your heat exchanger project.

At three of Yuba's plants at Honesdale, Pa., Buffalo, N. Y., and Richmond, Calif., are top heat exchanger engineers with national reputations for their progressive designs. Daily they design all types of heat exchangers, large or small, simple or complex... heat exchangers which operate at vacuum or to pressures of 5000 psi, at temperatures below zero or to 1000 F and higher . . . heat exchangers made of all kinds of metals: carbon steel, alloy steel, aluminum, nickel, and non-ferrous alloys such as the new silicon bronzes... heat exchangers with bundles having a few tubes or as many as 7500, with heat transfer surfaces up to 15,000 and 20,000 sq. ft.

Yuba is experienced... some of its divisions having made heat exchangers for as long as 50 years. Yuba has outstanding techniques... many of its heat exchangers having been "firsts" in their fields. Yuba is nationally recognized... in the chemical, oil, gas, power, mechanical and heating industries.

Buy Yuba. Its plants in both the East and the West mean convenience for you, speedy delivery, service . . . but, above all, well-engineered heat exchangers tailor-made for your own process.

YUBA

Divisions Manufacturing Heat Exchangers

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ADSCO DIVISION, BUFFALO, N. Y.

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Branch Offices and Representatives in Principal Cities

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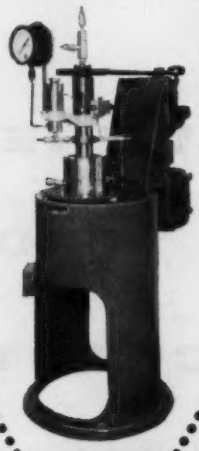
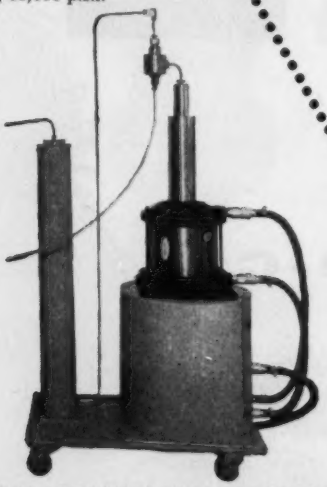
STIRRED AUTOCLAVES

Autoclave Engineers offers a range of standard design, high pressure stirred Autoclaves up to 40,000 p.s.i. Capacities from 1 liter to 30 gallons. Available with both rotating impeller or propeller agitation. Send for Bulletin 1257.



PUMPS

Autoclave Engineers offer a series of high pressure hydraulic pumps ranging in size and capacity from small hand operated pumps to air driven pumps developing 60,000 p.s.i.



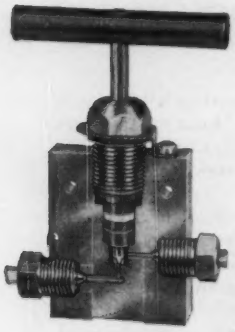
MAGNE DASH AUTOCLAVES

Magnetically agitated autoclaves for pressures to 30,000 p.s.i. No stuffing box or external moving parts. Standard units from 100 ml. to 1 gallon capacity in stock. Special units up to 5 gallons capacity available on order. Send for Bulletin 1051-B.

See This Equipment
BOOTH No. 346
Nat'l. Chem. Exposition
N. Y. Coliseum
Dec. 2-6

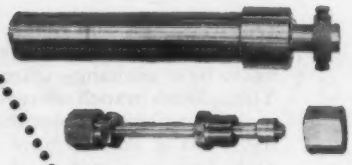
VALVES

A wide choice of *standard* valves and fittings for 1/8″ to 9/16″ O.D. tubing are *available from stock.* Send for Bulletins 255 (4,000 p.s.i.), 256 (10,000 p.s.i.), 555 (30,000 p.s.i.), 455 (60,000 p.s.i.) and 857 (micro series).



REACTORS

Autoclave Engineers builds an extensive range of non-agitated pressure vessels for laboratory and pilot plant applications as reactors, accumulators, scrubbers, etc. Standard sizes using AE patented self-sealing closures and confined gasket closures are available from stock. Other sizes and types of closures for specific requirements also are available. Send for Bulletins 357 and 356.



COMPRESSORS

The Andreas Hofer Compressor has gained world-wide acceptance as the most efficient small compressor on the market. Autoclave Engineers are sole distributors for Andreas Hofer Compressors in the U. S. Send for our Hofer Compressor Catalog.

PACKAGE UNITS

Autoclave Engineers designs, builds and prepares for assembly in your plant Pilot Plant Units for flow or batch operations as packaged or turn-key installations complete with reactors, pumps, compressors, valving and instrumentation. Our engineers will be glad to consult with you in the design and layout of such a unit to meet your specific requirements.

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Men in the Industry . . .

promotion, Johnston was classified as a senior chemical engineer, group leader.

Siegman, who was previously classified as a senior chemical engineer, group leader, has been named section head, Process Development section.

Davies has been promoted to Group Leader, Development Section. Prior to his recent promotion, he was classified as associate chemical engineer and was assigned to the Process Design section, Development division.

Chandler

Brandenburg

H. H. Chandler, superintendent of The Texas Co.'s Eagle Point refinery at Westville, N. J., has been assigned executive duties in London, England, as deputy shareholder's representative. Chandler, who has been in the Refining department since he joined the company in 1932, will spend three months studying other phases of Texaco's operations before reporting to the London office.

Chandler was succeeded as superintendent at Eagle Point by **V. K. Brandenburg,** assistant superintendent of Texaco's Lawrenceville, Ill., refinery.

It was also announced that **C. T. Swan,** assistant superintendent at the Casper refinery, succeeded Brandenburg as assistant superintendent at the Lawrenceville refinery. **G. A. Collins, Jr.,** assistant supervisor, Refinery Productions division, New York, replaced Swan as assistant superintendent at Casper.

Ralph A. Cardello has been appointed a section head in the planning engineering division of Esso Research and Engineering Co. In his new post, Cardello will supervise project groups developing plans for the design of new refining and petrochemical plants for affiliates of Standard Oil Co. (New Jersey). He is currently on an assignment at the Bayway refinery of Esso Standard Oil Co.

William R. Blackstock has been appointed product development manager of the Chemical division of Delhi-Taylor Oil Corp. Blackstock will be in charge of market research and product development in petrochemicals.

A graduate of Carnegie Institute of Technology with a B.S. degree in chemical engineering, Blackstock was recently associated with Pittsburgh Coke and Chemical Co.

William A. Reaman has been appointed manager of International Petroleum Company, Ltd.'s Cartagena refinery in Colombia. The refinery is now undergoing test runs and will be inaugurated in December. Reaman joined an Interna-

USG® SUPERGAUGE® . . .
assures accurate, dependable process indication

USG's exclusive Arc-Loc® Movement is one reason why USG Supergauges provide many years of sustained accuracy and dependability.

The sector of the movement is stainless steel, with nylon-faced gear section. Nylon-to-metal bond stabilizes the nylon against expansion and contraction . . . assures proper mesh with stainless steel pinion under severe temperature and moisture conditions. Movement is also available in all stainless steel if desired.

Mono-Unit Construction permits easy removal of complete gauge movement assembly for inspection and adjustment. Accurate calibration easily made from the rear. No need to remove dial or pointer.

Supergauges are available in 4½", 6" and 8½" sizes for pressures to 20,000 psi. Call your local USG Distributor today . . . see the "Yellow Pages" of your phone book . . . or write for complete information on gauge styles and construction.

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MORE THAN 50,000 TYPES OF GAUGES • SUPERGAUGES • SOLID FRONT GAUGES • RECEIVER GAUGES • TEST GAUGES • RECORDERS • CONTROLLERS • TRANSMITTERS • PSYCHROMETERS • AVIATION INSTRUMENTS

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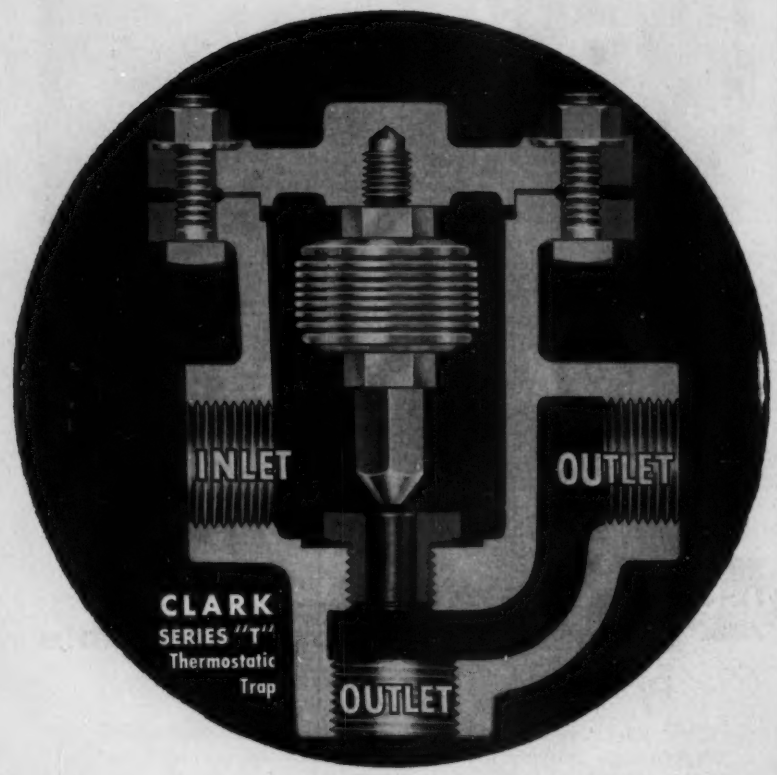
Clark

FITS TO A "T"



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Men in the Industry . . .

tional subsidiary in Colombia twenty years ago. He has also worked for the company in Coral Gables, Fla., and in Talara, Peru, where he became refinery superintendent.

In his new position Reaman replaces **H. Curtis Carroll,** who is retiring from the company after more than 28 years of service.

M. David Haynes, superintendent of crude, coking and cracking at Tidewater Oil Co.'s new Delaware refinery, has been advanced to the newly created post of refinery superintendent. In the new post, Haynes will be in charge of all processing operations.

Haynes

A Tidewater employee since 1929, he joined the company as a development engineer at the former Bayonne refinery. Haynes was named chief process design engineer in 1947 and transferred to Alhambra, Calif., in 1954 as a member of the group supervising the design of the Delaware refinery. He returned to Delaware in July of last year.

Born in Andover, Mass., he graduated from the Massachusetts Institute of Technology with a B.S. degree in chemical engineering.

John W. Packie has been appointed coordinator of engineering services and research by Esso Research and Engineering Co. The firm does the planning and design engineering for refineries operated by other Standard Oil Company (New Jersey) affiliates around the world.

Packie, a veteran of 28 years' service with the company, has been manager of the engineering coordination office. He will be succeeded in that post by **Luther Martin,** previously associate director.

John H. Schaefer, formerly vice president of manufacturing, has been appointed staff vice president of Ethyl Corp.

Glenn O. Hayes, director of the Employee Relations department and former manager of the company's Houston manufacturing plant, has been named general manager of the Manufacturing department and will be in charge of all manufacturing activities.

J. G. Hough, general superintendent of petrochemical manufacturing for Continental Oil Co., has been promoted to assistant general manager of the petrochemical department.

Also, Paul E. Geiser, director of petrochemical product quality has been promoted to manager of the department's detergents division. He will be responsible for the general business operations of the company's petrochemical plants at Chicago and Baltimore.

W. B. Strobel, director of petrochemical projects developments has been made manager of the department's chemicals division, with responsibility for the general business operations of Conoco's plants at Gretna, La., and Trainer, Pa.

Hough became associated with Conoco

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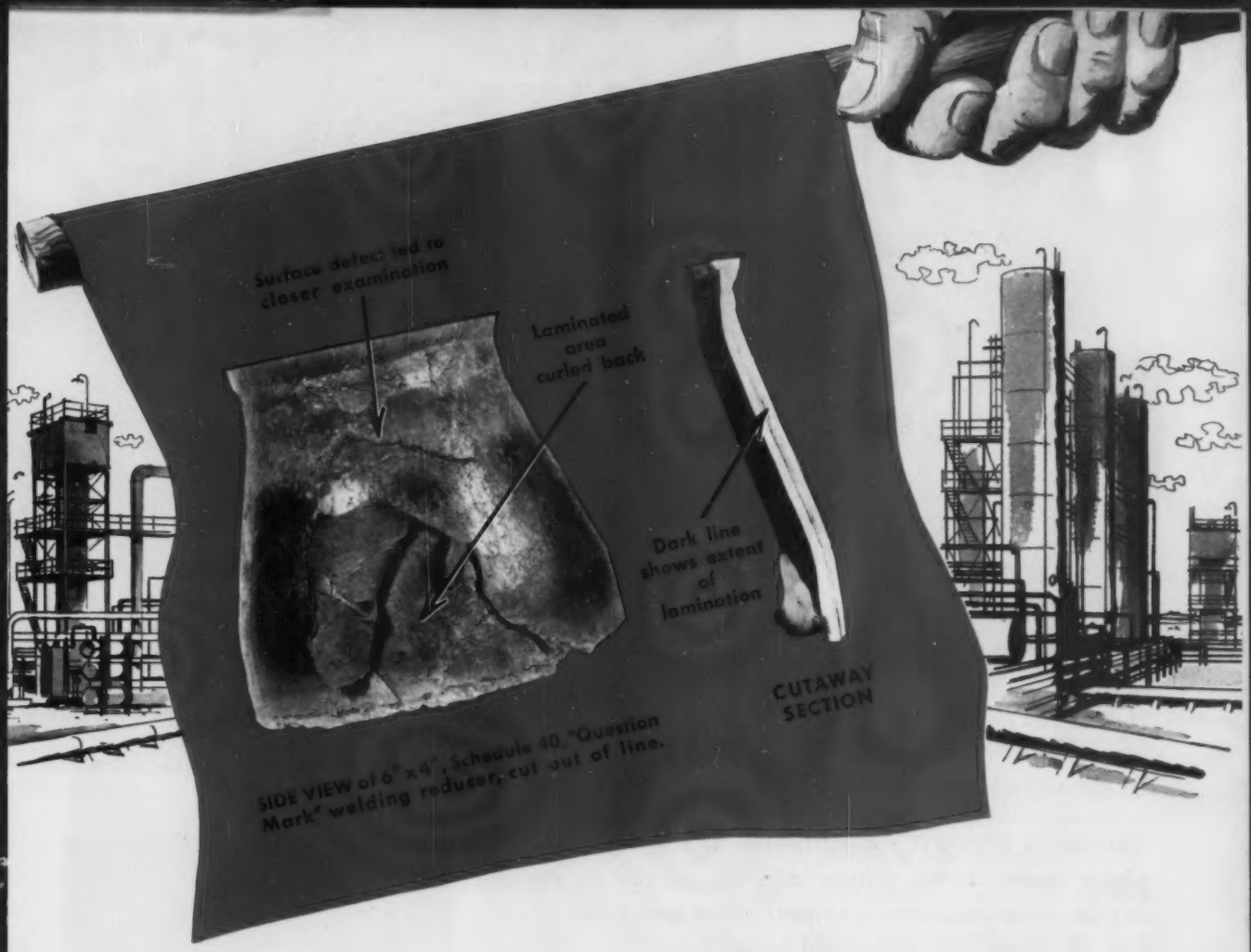

Surface defect led to closer examination
Laminated area curled back
Dark line shows extent of lamination
CUTAWAY SECTION
SIDE VIEW of 6" x 4", Schedule 40, "Question Mark" welding reducer, cut out of line.

Watch out for the after-costs of *Question Mark* fittings!

Unknown fittings may look like a bargain on the price tag, but watch out for the consequences!

Surface defects led to the above "Question Mark" fitting being cut from the piping. Further examination showed the steel inside was laminated. Pieces cut out literally fell apart. Here was an open invitation to serious trouble . . . lost production, wasted dollars and possible human casualties.

This is another example of a dangerous situation posed by unknown fittings of questionable quality . . . a serious threat to the safety and economy of well-engineered piping.

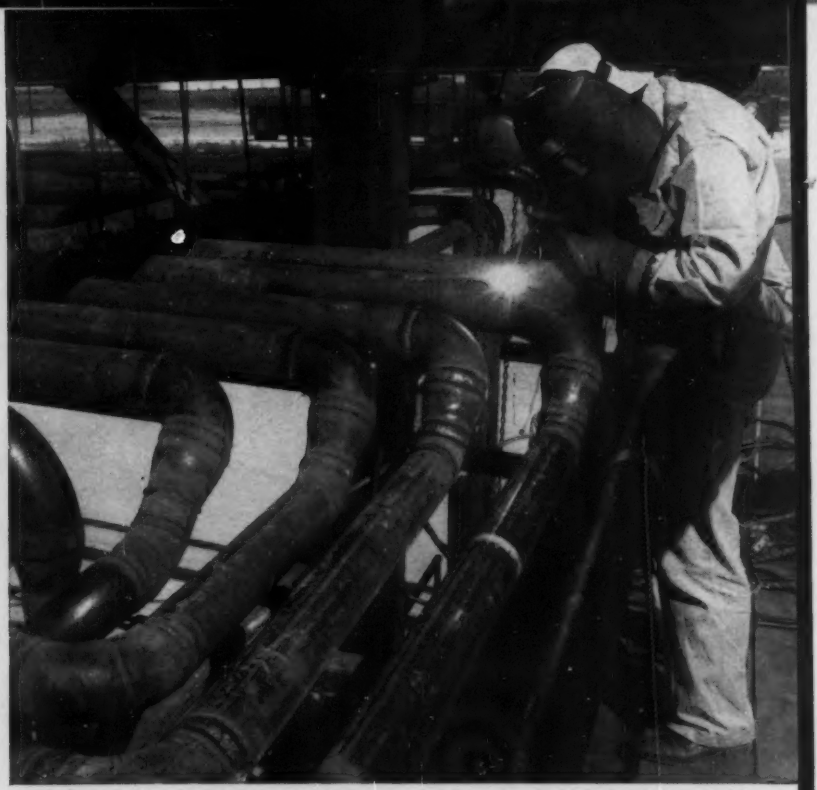
You can avoid these risks by specifying KNOWN fittings!

DANGER! *Your first warning of Question Mark fittings is their lack of complete, permanent identification of manufacturer, wall thickness, weight, material . . . as required by A.S.A. code.*

A message in the interests of top quality piping
. . . by Tube Turns, Louisville, Kentucky

YOUR SAFEGUARD

Safeguard your piping investment with known fittings!



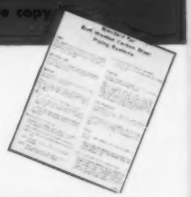
TOP QUALITY! *Directional and size changes in this process piping are made with* TUBE-TURN *Welding Elbows and Reducers . . . recognized for their unsurpassed uniformity and quality.*

The cost of fittings is a small fraction of the total cost of a piping system. To buy "cheap" fittings and run the risk of impairing the performance of your entire system can, therefore, be "penny wise and pound foolish."

When you specify and buy TUBE-TURN* products, you know your investment is safeguarded by unsurpassed quality of fittings and flanges. They meet all American Standard and Safety Code requirements. Each product is permanently marked with complete size and material designation.

COMPLETE LINE! *Your nearby Tube Turns' Distributor gives you prompt delivery from the complete line of more than 12,000 Tube Turns' stocked items. Photo courtesy The Ross-Willoughby Co., Columbus, Ohio.*

STANDARD for Butt-Welded Carbon Steel Piping Systems. Covers materials, assembly methods and welding procedures to use for safe, economical and maintenance-free piping. Mail the coupon for your free copy.



TUBE TURNS, Dept. Y-9
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Please send new Standard for Butt-Welded Carbon Steel Piping Systems.

Company Name _____

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City _____ *Zone* ___ *State* _____

Your Name _____

Position _____

Available from your nearby TUBE TURNS' *distributor*

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Men in the Industry . . .

in 1947 and served three years each as assistant superintendent and superintendent of the company's Baltimore plant before becoming general superintendent of petrochemical manufacturing in 1953. He transferred from Baltimore to Houston in the same capacity in 1956.

Geiser joined Conoco in 1948 as coordinator of technical services at Baltimore. He was named superintendent of the Chicago petrochemical plant in 1952 and transferred to petrochemical headquarters in Houston three years later as market development representative. He was made director of petrochemical product quality early this year.

Strobel joined Conoco's manufacturing department in 1948 at Ponca City, Okla. He transferred to Houston in 1951 and joined the petrochemical department that year as technical assistant to the manager. He was promoted to director of petrochemical projects development three years later and in 1956 received a Sloan Fellowship and took one year's leave of absence from Conoco for advanced study at the Massachusetts Institute of Technology.

Dr. Thomas F. Doumani has been appointed senior research associate at the Union Oil Co. Research Center, Brea, Calif. Dr. Doumani has been with Union Oil Co. and its petrochemical subsidiary since 1939. He recently completed a year's special assignment for Union at the Argonne National Laboratory. Dr Doumani holds a Ph.D. from the University of Washington and is a Fellow of the American Association for the Advancement of Science.

Doumani

Edward D. Shanken has been appointed executive secretary of the American Association of Cost Engineers.

Shanken is a graduate of The Pennsylvania State University where he received his M.S. degree in 1954.

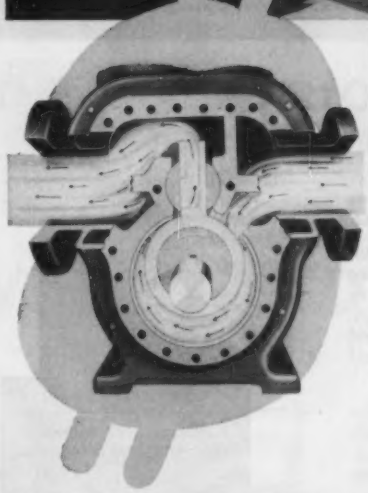
Since graduating he has been associated with the University of New Hampshire, and is presently assistant director of the University Extension Service.

Shanken

The office of the Executive Secretary has been established on the campus of the University of New Hampshire.

Thomas W. Phelps, assistant to the chairman of the board of Socony Mobil Oil Co., Inc., New York, was elected 1958 National Chairman of the Oil Information Committee, public relations arm of the API.

Phelps succeeds **M. S. Hauser,** public relations director of The Ohio Oil Co. Findlay, Ohio. He will assume the chair-



BUT • • •

Gambling on a Pump to Handle Bunker is Too Risky!

Take a KINNEY Pump. On the record, it will outlast any other pump in handling heavy viscous materials. While low depreciation is interesting . . . the BIG vitally important advantage in a KINNEY Pump is — FREEDOM FROM DOWN-TIME! It can cost you thousands to have a pump "conk" out at the wrong time . . . and chances are that's the time a "price" pump will fail. That's why, in viscous oil service, the odds are in your favor with a —

Kinney®

ROTARY PISTON PUMP

The design of these Pumps, with oversize suction ports, makes them particularly suited to handle viscous liquids such as: lubricating and fuel oil, asphalt and other sluggish or gassy liquids. Positive displacement with high volumetric efficiency—frequently employed for calibrated output. Capacities 1 to 500 gpm, pressures up to 100 psi, (and some sizes up to 250 psi).

The Model SD KINNEY Pump consistently outperforms other pumps handling Bunker "C" oil, Tars and Asphalt at temperatures at least 20° cooler. Consider the time saved getting viscous materials up to pumping temperature. Consider the fuel saved over the course of a year. The savings are important, but the big, vital point is in the savings in down-time and the peace of mind you enjoy with a KINNEY Rotary Piston Pump on the job!

WRITE . . .
for Bulletin L-51-A fully describing KINNEY Rotary Piston and the famous Heliquad Gear Pumps.

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3596L WASHINGTON STREET • BOSTON 30 • MASS.

Please send me Bulletin L-51-A containing full information on KINNEY Rotary Piston Pumps.

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

PREMETCO SERVICE REPORT
Tatum Gasoline Plant's first stage processing and chiller units have year 'round Premetco insulation protection.

Weatherproofing for Outdoor Gas Processing Equipment

New Tatum Gasoline Plant

ALUMINEL PROTECTED

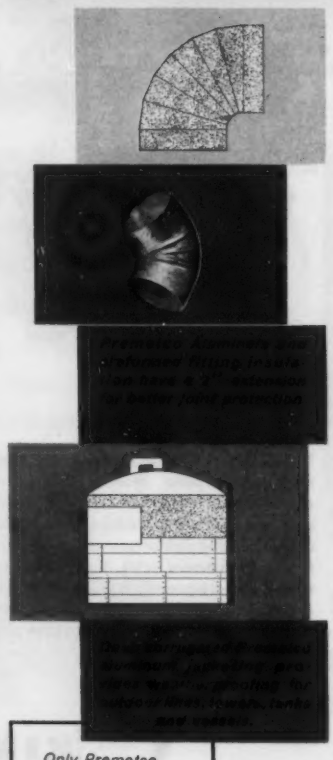
This compression refrigeration type gasoline plant depends upon exact temperature control. Insulated equipment subjected to temperature variations is located outdoors. The problem was to protect this exposed insulation against cracking, weather and accidental damage.

Certified Insulation Company, called in for the job, suggested new Premetco Aluminels and deep corrugated aluminum jacketing. Made of pure aluminum and completely preformed with a bonded-to-metal moisture barrier, Premetco insulation covering gives years of trouble-free weatherproofing. At the Tatum plant the towers, lines, chillers and compressor exhaust manifolding all received Premetco Aluminum protection.

Using Premetco insulation protection reduces labor costs by as much as 75%. Additional savings are realized when changing lines as Premetco Aluminels and jacketing are easily removed and reinstalled.

For your next installation be sure to specify Premetco for better insulation protection.

Complete on hand stock available for pipe sizes 1½ inches through 12 inches . . . write or call today . . . material samples on request.



Only Premetco guarantees 100% satisfaction.

Excellent territories open to manufacturers representatives. Inquire directly.

PREMETCO

PREFORMED METAL PRODUCTS CO., INC. *P.O. Box 1134 Shreveport, Louisiana*

Men in the Industry . . .

manship at OIC's next meeting in New York, December 5-6.

Vice Chairmen elected were:

R. H. Collacott, public relations director, The Standard Oil Co. (Ohio), Cleveland; **Russell D. Karns,** assistant to the president; Pan American Petroleum Corp., Tulsa; **G. A. Mabry,** manager of advertising and public relations, Humble Oil & Refining Co., Houston; and **Stewart Schackne,** public relations manager, Standard Oil Company (New Jersey), New York.

Donald R. Waugh of the OIC staff, New York, was elected Secretary.

Britt

Robbins

James R. Britt, formerly manager of the chemical plants division of Procon Inc., has taken over as general manager of Procon (Great Britain), Ltd., with headquarters in London.

Charles B. Robbins, Procon (Great Britain) general manager since 1952, has returned to Procon's home office here as assistant to the president.

Britt, a native of Louisiana, has been in the Procon organization since 1955. He was general manager of another Procon subsidiary prior to being assigned to the home office as manager of the chemical plants division in July, 1956.

Robbins joined Procon in 1951, after having been in charge of engineering and construction projects for Rust Engineering Co., Pittsburgh, and Rayonier Inc., Fernandina, Fla. He graduated from the U. S. Naval Academy, with a B.S. degree in engineering.

Kerryn King has been named general manager of the Industrial and Public Relations department of The Texas. Co. King was formerly assistant general manager and director of Public Relations. He will be succeeded as director of Public Relations by **Thomas D. Durrance,** who has been supervisor of Editorial Services.

Robert T. Kenney and **Thomas F. Brawner** were named assistants to the director of Public Relations with headquarters in Los Angeles and Houston.

Richard M. Johnson has been elected a vice president of Cosden Petroleum Corp., according to R. L. Tollett, president. Johnson, associated with Cosden since 1941, continues as director of sales, a post he has held since 1953.

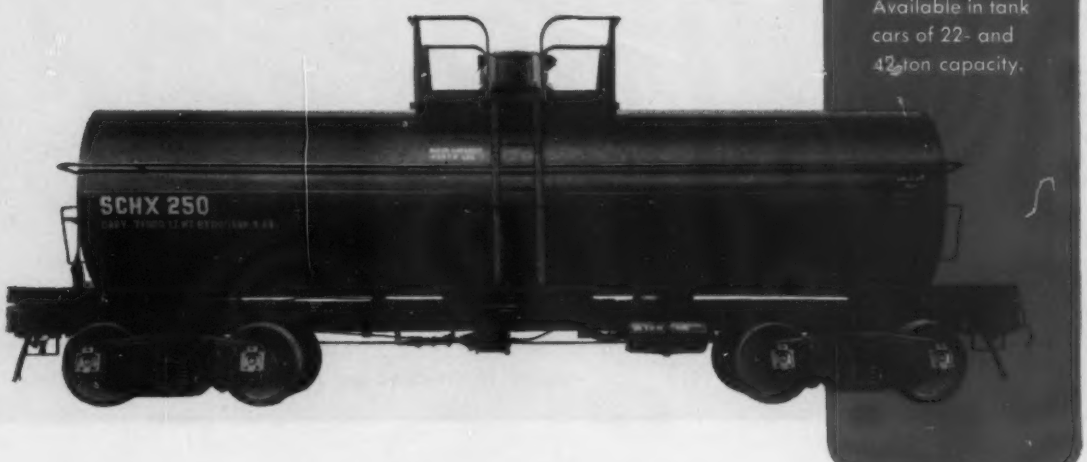
In another move, following the annual stockholder's meeting, the board of directors created the office of senior vice president. Elected to that post were **Marvin M. Miller,** head of the producing division, and **Dan M. Krausse,** head of the refining division. **Joe A. Moss** was elected assistant secretary and **R. O. Satterwhite,** assistant treasurer. All other officers were re-elected.

HF

HYDROFLUORIC ACID

anhydrous and aqueous

STAUFFER HAS IT...
IN QUANTITY AND QUALITY



Available in tank cars of 22- and 42-ton capacity.

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, N.Y.

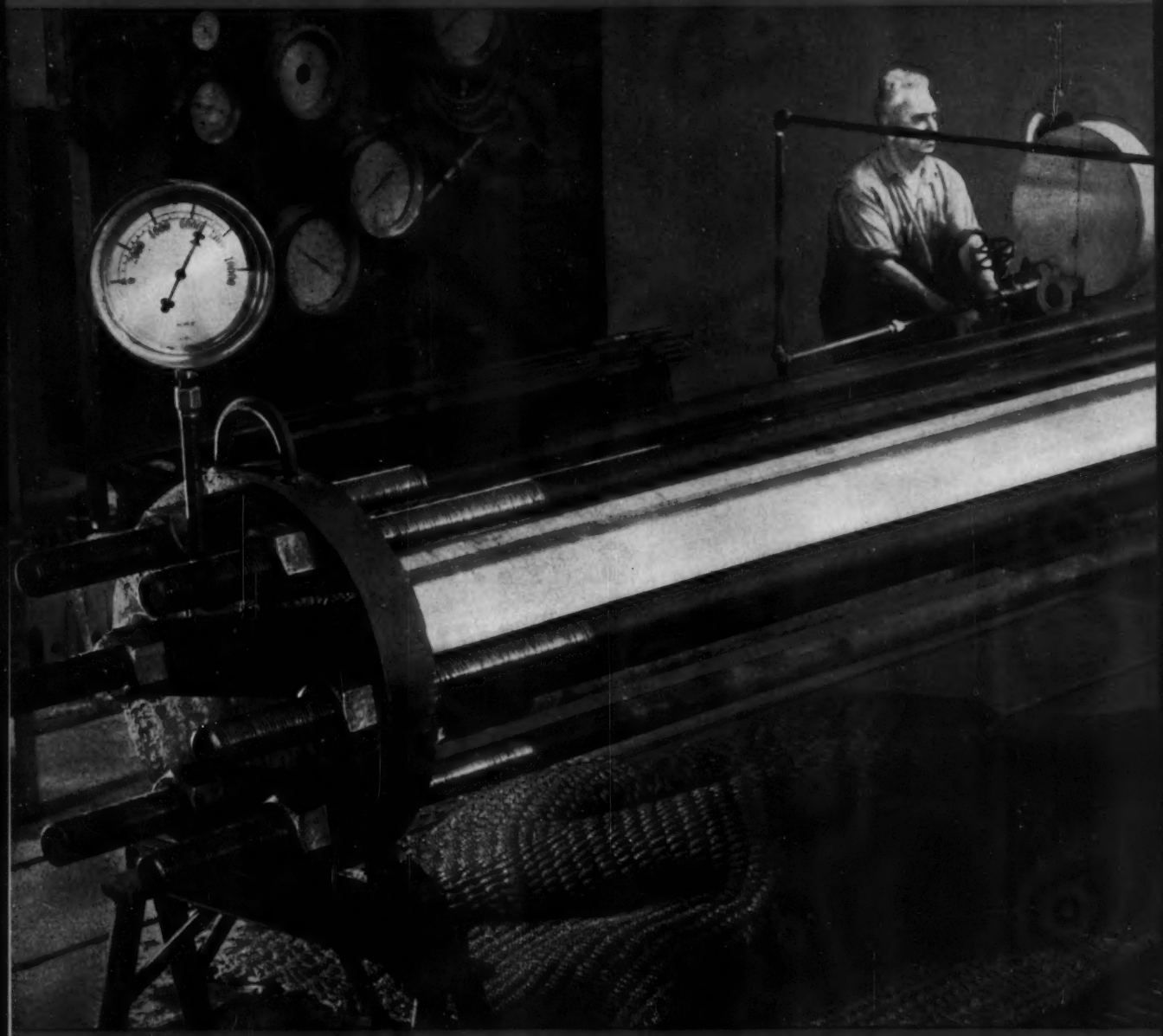
Prudential Plaza, Chicago 1, Ill. • 636 California Street, San Francisco 8, Calif.

NYOTEX CHEMICAL DIVISION, P. O. Box 9716, Houston 15, Tex.

Stauffer CHEMICALS SINCE 1885

For more data on advertised products, use Readers' Service Cards, last page.

STAINLESS STEEL CENTRIFUGALLY CAST MAY BE TI



ABOVE: Hydrostatic test rig used to qualify each length of pipe.

UNITED STATES PIPE & FOUNDRY CO.

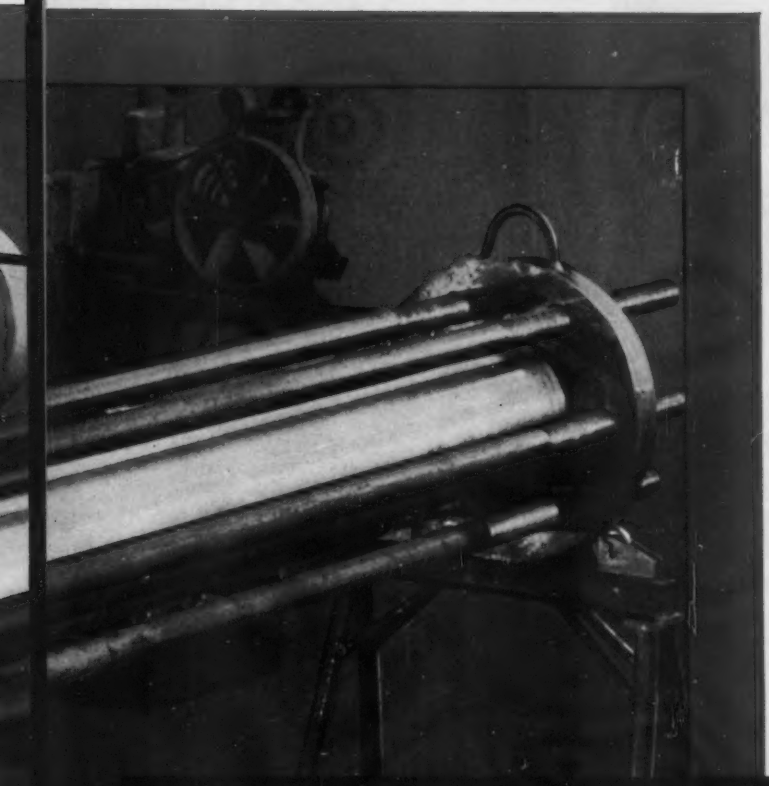
Steel and Tubes Division

STEEL & TUBES · U.S. PIPE · DIVISION

BURLINGTON, NEW JERSEY

SALES OFFICES: LOS ANGELES, SAN FRANCISCO, CHICAGO, ST. LOUIS, COLUMBUS, PITTSBURGH, HARTFORD, BURLINGTON

THE ANSWER TO YOUR PIPING PROBLEM



Patented U. S. Pipe process meets rigid refinery specifications

The men who design today's petrochemical plants, refineries or Atomic power plants are confronted with piping problems involving temperatures, pressures and corrosive conditions which only a few years ago would have been called impractical, if not impossible.

U. S. Pipe's Steel & Tubes Division recently completed a piping requirement for 700 feet of Type 316 Extra Low Carbon, columbium-bearing stainless for a large petrochemical plant, which is typical of the job metal mold centrifugally cast pipe is doing today under a patented manufacturing process with rigid Quality Control.

U. S. Pipe is headquarters for metal mold centrifugally cast alloy and stainless steel pressure pipe over a wide range of special and standard analyses —in large or small quantities.

Write and outline your piping problems. We may be able to help.

Note these exacting specifications on 316 Cb ELC Stainless Steel Pipe demanded by one of nation's leading oil companies:

MATERIAL REQUIREMENTS: Pipe shall conform to ASTM Specification A-362-52T.

CHEMICAL ANALYSIS: Modified AISI Type 316 Cb (ELC), with *one percent* spread on chrome and nickel.

FINISH: Each pipe to be turned, bored and faced to surface finish of 125 micro inch or better. O.D. tolerance plus 1/16″ minus 0″; I.D. tolerance plus 0″ minus 1/32″. Pipe size: 12″ O.D. × 1.17″ wall.

MECHANICAL TESTS: Tensile Tests — 2 tests required on each pipe after heat treatment; one at room temperature, one at 700° F.

INSPECTION REQUIREMENTS

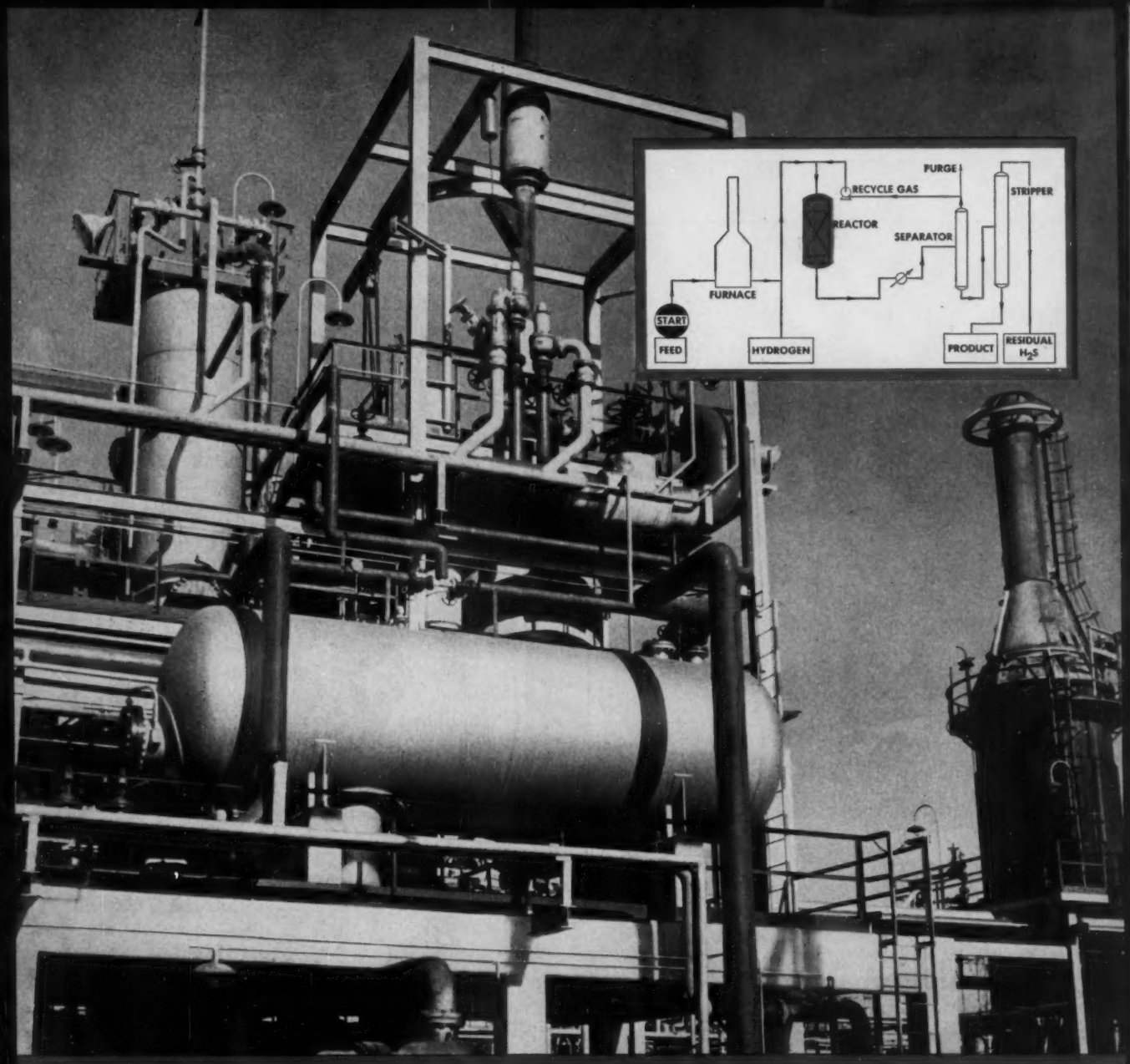
1. Etching test on sections cut from each end of pipe.
2. Radiographic Inspection — Required complete circumferential coverage of at least an 8″ wide section at each end of each pipe in accordance with ASTM Specification E71-52.
3. Fluid Penetrant—Entire O.D. and I.D. surface each piece.

HEAT TREATMENT: Heat for 4 hours at 2100° F.—2150° F., water quench, follow by 5 hours at 1500° F.—1600° F. Cool in still air.

HYDROSTATIC TEST: Each length tested to stress of either 90% of the minimum cold yield strength or a maximum pressure of 6800 psi —whichever is lower.

SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter—6″ to 50″
Wall Thickness—⅜″ and up
Length—Up to 16′
Types of Stainless—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E.L.C. grades.



19,500 B/D CRACKED HEATING OIL HYDROFINER, ESSO STANDARD'S BAYWAY REFINERY, LINDEN, N. J.

HYDROFINING CAN GIVE YOU TOP PERFORMANCE AT LOWEST INVESTMENT

Esso Research and Engineering offers you *Hydrofining*, a process now being applied to a greater variety of feed than any other hydrogen-treating process. *Hydrofining* uses by-product hydrogen to remove sulfur and other impurities *without yield loss*.

The process improves product stability, odor, color and other quality characteristics without the disadvantages of chemical or clay treating methods. *Hydrofining* is another achievement of the Esso Research program — 38 years of new process developments made available to refiners around the world.

Hydrofining experience has been gained from commercial units processing a wide variety of feed stocks such as naphthas, distillate fuels, lubes and waxes. This experience plus years of hydrogenation research gives us a unique opportunity to recommend the best design for your plant.

Twenty-three *Hydrofining* installations are on stream; eight more are in the construction or planning stage. Licensees enjoy benefits of continuing *Hydrofining* research. *Hydrofining* can play an important part in helping you process previously unattractive stocks into higher quality products. We would welcome your inquiry.

ESSO RESEARCH AND ENGINEERING COMPANY

15 West 51st Street, New York 19, N. Y.

Your key to progress... an Esso Research process

Reviewing New Books . . .

Handbook of Chemical Data

This convenient, pocket-size handbook does away with unwieldy references and charts. The book's small format is specially designed to render a handy, lightweight volume that is easily taken anywhere. The accurate and readily accessible tables of constants are extremely helpful and time-saving even to those who have access to a complete library.

This volume contains density, specific heats, vapor pressure, solubilities, refractive indices, and many other properties of organic and inorganic compounds. Also included is a table of mathematics.

(Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y., 629 pages, $6.75. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

"Higher Oxo Alcohols"

Lewis F. Hatch, technical consultant at Enjay Laboratories, has authored this book which is the first complete review of the oxo reaction.

It provides a thorough discussion of the extensive developments on the subject—covering all phases from production through application, and stressing its practical industrial implications as well as its theoretical aspects. In addition, it presents valuable new material about the most important derivatives of the process—the higher oxo alcohols.

Whether working with plasticizers, detergents, synthetic lubricants or herbicidal esters, one will find that this handy, authoritative work will fill an important place on his reference shelf.

A portion of this material presented in PETROLEUM REFINER, August, 1957, page 141.

(John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 120 pages, $4.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

"Modern Chemistry for the Engineer and Scientist"

In this book, 19 nationally know chemists, both academic and industrial, summarize the accomplishments and the newer methods of their respective fields.

The chapters are by no means confined to practical technology. Interesting developments in food or petroleum chemistry are presented. Even more emphasis is placed, however, on the newer fundamental methods of kinetics, thermodynamics, mechanisms of reactions, etc., which have no connection with 1956 corporate earnings, but in all probability will have marked influence on dividends in 1966 or 1976.

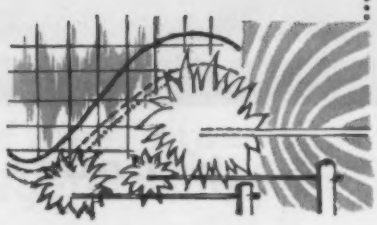
Among the outstanding features is a remarkable array of petrochemicals from crude oil suggested by Theodore Evans' discussion of The Petrochemical Industry. Paul H. Emmett, an outstanding scholar in catalysis, describes recent progress in that field, while the interests of mining and metallurgy are represented by several contributors.

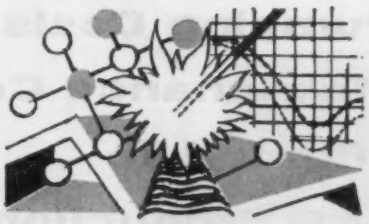
This volume is the third to have grown

CRACKING Problems with 316 and 347 Stainless?

CHAMPION'S 16-8-2 Electrodes Offer freedom from CRACKING

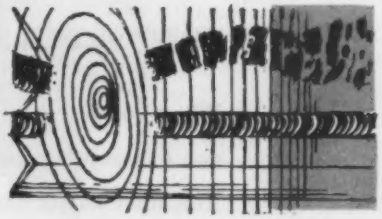
HERE'S WHY: New CHAMPION 16-8-2 Stainless Electrodes have a composition which has much higher hot ductility than any other grade of stainless. Produces freedom from cracking in weld, zone of fusion, or parent metal.





HERE'S WHY: Tests reveal that this composition is not subject to embrittlement on aging, and possesses very good stress-to-rupture properties.

HERE'S WHY: Lime type coating deposits extremely clean, sound weld metal. Handles well in all positions. Low spatter. Easy slag removal. Smooth, even and finely rippled weld bead.



Excellent mechanical properties are accomplished with CHAMPION 16-8-2 Welding Electrodes:

Yield	61,000 psi
Tensile	92,000 psi
Elongation in 2"	50%
Reduction of area	61.8%

The chemistry is closely controlled to produce less than 4% ferrite in the deposit.

Typical chemical analysis is as follows:

Carbon .08	Chromium 16.19
Manganese 2.24	Nickel 8.00
Silicon .37	Molybdenum 1.79

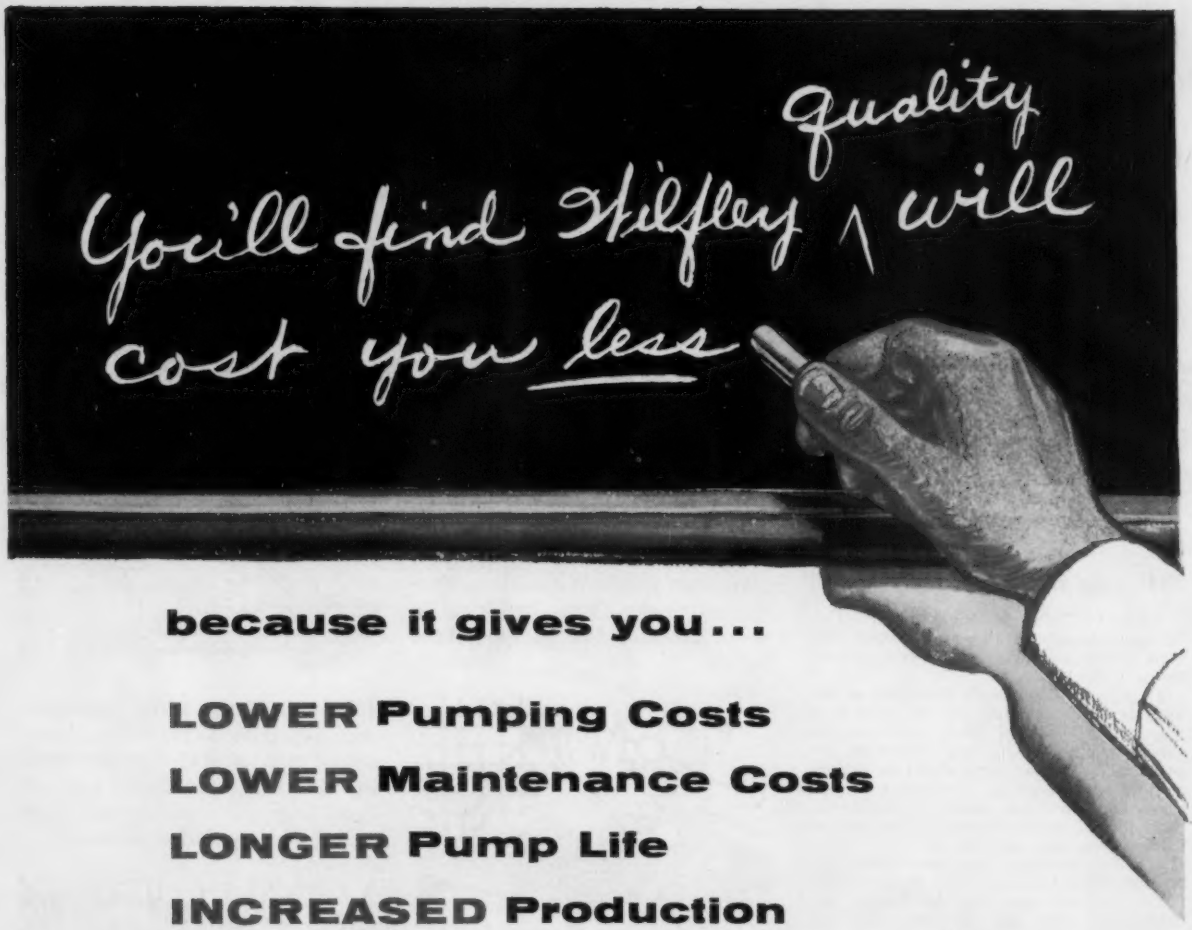
Other stainless requirements: CHAMPION offers a complete line of stainless electrodes in a full diameter range from 5/64" to 1/4", lime or AC-DC coated.

FOR FULL DETAILS on CHAMPION'S 16-8-2 or other stainless electrodes write to:

The CHAMPION Rivet Co.

Cleveland 5, Ohio • East Chicago, Indiana

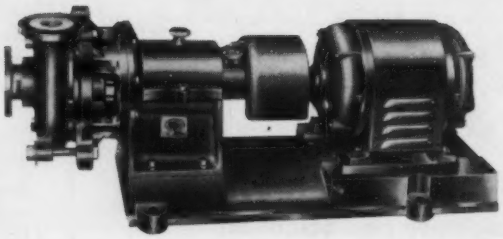
For more data on advertised products, use Readers' Service Cards, last page.



because it gives you...

LOWER Pumping Costs
LOWER Maintenance Costs
LONGER Pump Life
INCREASED Production

When you buy quality, Wilfley quality, you buy *superior* performance. You start *saving* money the moment a Wilfley Acid Pump goes into action. Let Wilfley solve your pumping problem. Write, wire or phone.



Wilfley Sand Pumps
"Companions in Economical Operation"
Wilfley Acid Pumps

WILFLEY
ACID PUMPS

Individual Engineering on Every Application

A. R. WILFLEY and SONS, INC.
DENVER, COLORADO, U.S.A. NEW YORK OFFICE: 122 EAST 42ND STREET, N.Y. CITY, 17

New Books . . .

out of the highly successful engineering extension lecture courses at the University of California at Los Angeles.

McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 36, N. Y., 441 pages, $9.50.)

Laboratory Manual of Batch Distillation

This is an introduction to the technique of batch distillation. Its main purpose is to provide help and guidance to the chemist who uses laboratory distillation as a tool for analysis, separation, and purification of base materials, intermediates, or products, but does not intend to specialize in the field. The contents of the manual have been designed to conform to this objective.

After those theoretical principles which bear directly on the practice of laboratory distillation have been explained, the design and construction of simple fractionation apparatus and its accessories are discussed. Special attention is given to the testing of distillation equipment.

More refined aspects of laboratory distillation, such as the application of continuous distillation, azeotropic and extractive distillation, the use of high-vacuum equipment, and the design of highly automatized apparatus have been omitted from discussion. The interested reader will, however, find at the end of the book a systematic survey of literature which may provide an entry into the more specialized branches of the technique.

(Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 126 pages, $3.50.)

The Industrial pH Handbook

The Process Instruments Division of Beckman Instruments, Inc., has announced the availability of this book. This handbook is the first manual ever published giving such thorough coverage of industrial pH information under one cover. Compiled and edited by Thomas J. Kehoe, Application Engineering Supervisor, the handbook reviews industrial pH control systems, their principles, application engineering and equipment, providing a convenient reference source on pH for persons involved in designing, engineering, purchasing, and operating industrial pH systems. Systematic subject organization plus alphabetical indexing makes for easy reference to the subjects covered. The handbook contains approximately 100 illustrations, plus charts, tables, and a bibliography of reference literature on pH measurement.

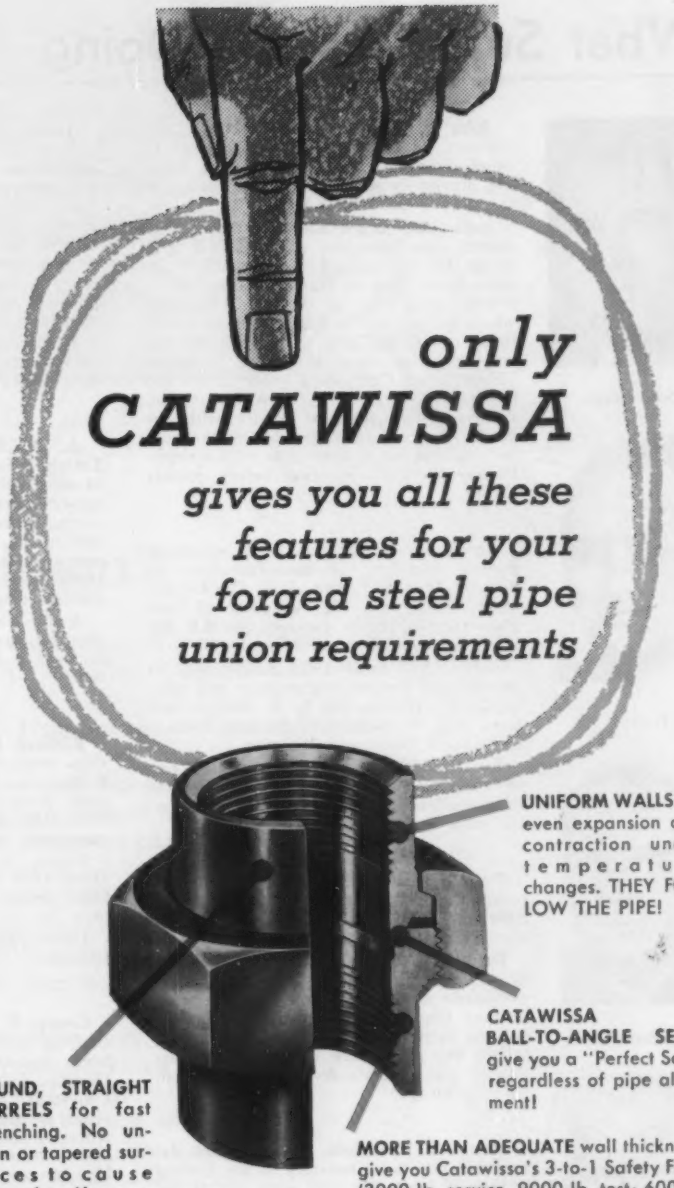
(Beckman Process Instruments Division, Fullerton, California, 80 pages, $2.00.)

"Water Supply and Treatment"

National Lime Association has just published the eighth revised, enlarged edition of this book which has had more than 50,000 copies printed since the first edition in 1934.

This edition deals with sources of water and methods of purification. Coagulation, filtration, fluoridation, softening, and disinfection are some of the topics covered. These are discussed in connection with the type of use intended for the water—whether municipal or industrial.

(National Lime Association, Washington 25, D. C., 221 pages, $2.00 plus 12 cents postage.)

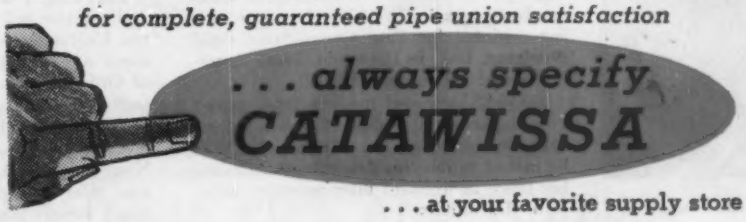

only
CATAWISSA
gives you all these features for your forged steel pipe union requirements
UNIFORM WALLS for even expansion and contraction under temperature changes. THEY FOLLOW THE PIPE!
CATAWISSA BALL-TO-ANGLE SEATS give you a "Perfect Seal" regardless of pipe alignment!
ROUND, STRAIGHT BARRELS for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!
MORE THAN ADEQUATE wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000-lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!

Get your free copy of Catalog 56 showing the complete Catawissa line . . . write direct or stop at your favorite supply store.

CATAWISSA VALVE & FITTINGS COMPANY • CATAWISSA, PENNA.

for complete, guaranteed pipe union satisfaction



. . . at your favorite supply store

For more data on advertised products, use Readers' Service Cards, last page.

What Suppliers Are Doing . . .

Saussaman

John D. Saussaman has ben appointed division superintendent in the Iron and Steel division at the Kaiser Steel plant. He previously served as superintendent of the plant's three Blast Furnaces.

Saussaman joined Kaiser in 1946 as assistant superintendent of the Blast Furnaces. He was named superintendent two years later. Born in Harrisburg, Pa., Saussaman went on to Lehigh University where he received a B.S. degree in metallurgy in 1939. Upon graduation he was employed for two years by Carnegie-Illinois Steel Corp. as a practiceman and blower in the Blast Furnace department. Following five years of service with the U. S. Army as an officer during the war, he returned for a short time to Carnegie-Illinois Steel Corporation before joining Kaiser.

Krickl

Anson W. Krickl has been appointed general manager of manufacturing by Badger Manufacturing Co., Cambridge, Mass. Krickl is a 1937 graduate of Yale University where he received his B.S. degree in chemical engineering.

From 1937 until 1953 Krickl was in process and project engineering and sales executive activities for E. B. Badger and Sons and its successor, Badger Process Division of Stone and Webster.

In 1953, Krickl joined Catalytic Construction Co., Philadelphia, as assistant to the president in charge of new business. He joins Badger from this position.

Vaupel

Carl H. Vaupel has been named vice president and general manager of the Aldrich Pump Co., Allentown, Pa. He succeeds **G. Donald Ruhe** who is retiring.

Formerly resident manager of Cooper-Bessemer Corp. in Grove City, Pa., Vaupel previously served as assistant to the president of that corporation. His earlier affiliations included Fairbanks-Morse & Co., Beloit, Wis.; Northern Pump Co., Minneapolis; and Aircraft & Diesel Equipment Corp., Chicago.

Robertson

Harry A. Robertson, Jr., has been assigned a new sales territory in the central section of Ohio. He will work out of the Cleveland branch of The Garlock Packing Co., Palmyra, N. Y.

Robertson graduated from the University of Colorado with a B.S. degree in business administration and received his electrical engineering training with the United States Navy.

Goree

Edwin T. Goree has ben promoted to assistant general sales manager of Bucyrus-Erie Co. A native of Calexico, Calif., Goree received his B.S. degree in mining engineering from the University of California at Berkeley in 1937. He was a mining engineer for Pato Consolidated Gold Dredging, Ltd., in Colombia, South America from 1937 through 1940.

In 1947 he joined Bucyrus-Erie's export sales department, and in 1951 was named field representative for Mexico. In 1955 he moved to Bucyrus-Erie's South Milwaukee office as assistant sales manager, excavator distributors.

Joseph W. Lewis has been named assistant to the president of Beckman Instruments, Inc. For the past six years Lewis has been manager of Arnold O. Beckman, Inc., in South Pasadena, Calif. Prior to that he was associated for 10 years with United States Steel Products Co., serving as manager of industrial relations and later as assistant to the West Coast vice president and general manager in Los Angeles.

Lewis graduated from California Institute of Technology in 1941, receiving a B.S. degree in mechanical engineering.

Lewis

A. R. Knerler has joined Jones & Laughlin Supply Division's staff in Tulsa as sales promotion-public relations supervisor. Knerler left Jones & Laughlin Steel Corp., Pittsburgh, where he was in the advertising department for ten years. He was advertising assistant and worked with trade paper advertising, sales literature, exhibits displays and public relations.

A native of Pittsburgh, Knerler attended the University of Pittsburgh, where he received a degree in business Administration.

Knerler

Richard L. Lightstone has been made sales engineer in the Instrument division, Robertshaw-Fulton Controls Co. Lightstone formerly was in charge of the Indianapolis office of Harry Wright, Jr. and Associates, distributors of space heating, pumping and boiler room equipment. From 1950 to 1952 he served as Dayton, Ohio district manager for Steam Economies Co.

Lightstone is a graduate of Antioch College.

Lightstone

George E. Montgomery, with Universal Packing & Gasket Co. for five years, has been appointed sales manager of the Houston firm. Previously a salesman with Universal, his experience includes two years as the company's California representative and several years handling OEM and industrial accounts in Universal's Houston and eastern territories.

Montgomery has been associated with the packing business in manufacturing, engineering and sales capacities for some twenty-five years and is a member of API.

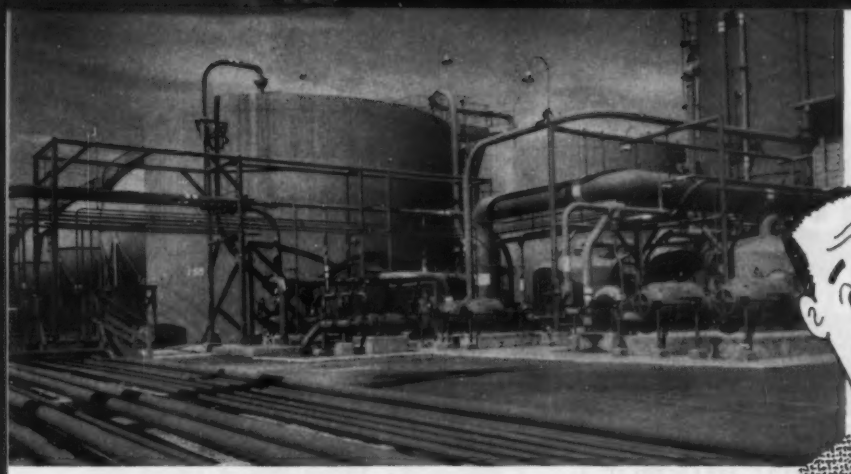
Montgomery

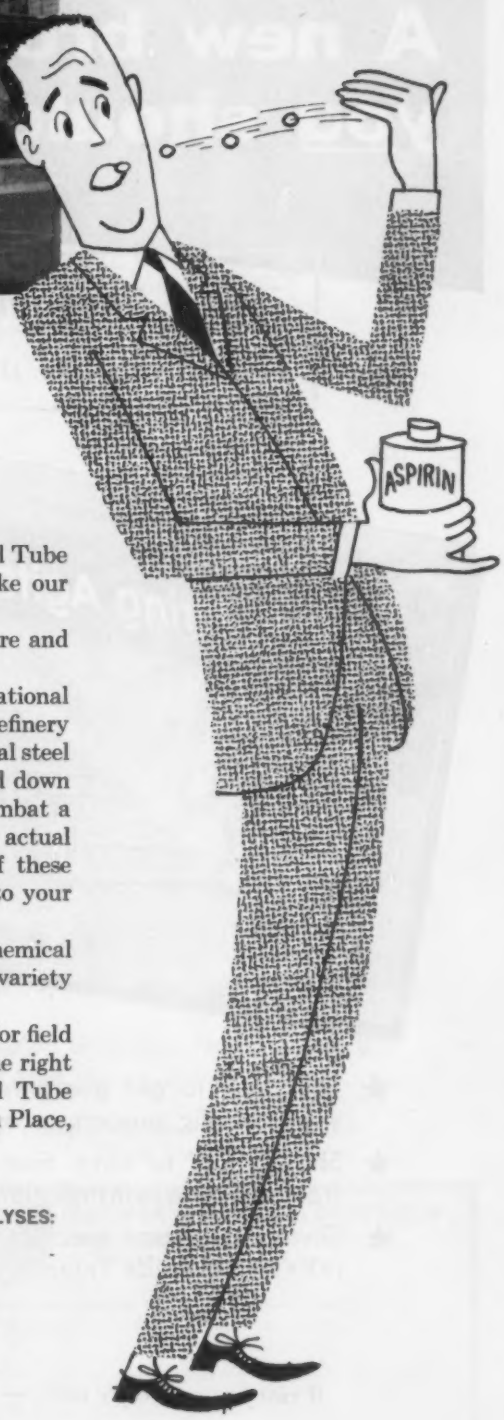
Joseph F. Wright has been appointed senior engineer in charge of engineering test facilities by Cameron Iron Works, Inc., Houston. Wright attended Carnegie Institute of Technology and upon graduation as a mechanical engineer in 1937, joined Weirton Steel Co., Weirton, W. V.

Following a series of courses in interior and exterior ballistics at George Washington University, Washington, D. C., he became an associate engineer with Bureau of Ordnance, Navy Department, in Washington.

In 1942 Wright became the chief engineer of the New Castle Defense Plant, New Castle, Del. From 1944 to 1947 he was chief project engineer in the Ordnance Research and Development division

Wright





You say you have a corrosion problem?

BEFORE IT DEVELOPS into real trouble, why not give National Tube a call. Refinery tubing problems are our specialty. We make our living by solving them.

Corrosion problems? Acid problems? Temperature, pressure and oxidation problems? We solve them all.

How do we do it? Here's how: we've kept case histories at National Tube for over 60 years—precise data on thousands of tough refinery tubing problems. Each of these problems was solved by a special steel alloy. This accumulation of alloy information has been boiled down to 24 different steel tube analyses, each one designed to combat a specific set of refinery conditions. Long, rigorous testing in actual refinery service has proved the capabilities of every one of these analyses. We feel confident that one of them is the answer to your problem.

In addition to the two dozen analyses shown here, other chemical compositions are available in tubular products, and a wide variety of temperature problems is presently under study.

So, get in touch with us. Our Mill Service Force, available for field consultation, will help you find just the alloy you need, at the right price, to meet your refinery conditions. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

HERE ARE NATIONAL TUBE'S TWO DOZEN DIFFERENT TUBE ANALYSES:

Carbon	5 Cr, ½ Mo	17 Cr
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8
1 Cr, ½ Mo	7 Cr, ½ Mo	18-8 Ti
1¼ Cr, ½ Mo	8 Cr, ½ Mo	18-8 Cb
2 Cr, ½ Mo	8 Cr, 1 Mo	18-8 Mo
2¼ Cr, 1 Mo	9 Cr, 1 Mo	25-20
2½ Cr, ½ Mo, ¾ Si	12 Cr	3½ Ni
3 Cr, 1 Mo	12 Cr, Al	5 Ni

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
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COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
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UNITED STATES STEEL

A new brochure you should have

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★ Shows how to save time and money, from selection to installation to operation.

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Suppliers . . .

of the Rheem Manufacturing Co., Baltimore.

After the war Wright accepted the position of assistant to the vice president of the H. Belfield Co., Philadelphia.

Wright joined Cameron in August, 1955, as an application engineer and until this appointment has been in charge of field testing Cameron's valve products.

THE OHIO STEEL FOUNDRY CO., conducted a two day "Steel Casting Conference" last month.

E. H. Mollman, sales manager of the foundry's Fittings division advised that approximately 60 engineers and metallurgists of the various oil companies and chemical industries of the U. S. and Canada were represented at the conference.

The first day of the conference consisted of a tour of the foundry showing the latest foundry techniques applied to the pressure castings used in their plants.

A technical sessi . was held the second day where three papers were given by the Ohio Steel personnel.

AMERICAN INDUSTRIAL CHEMICAL CO., a Division of Amerace Corp., has named **Dr. Albert H. Cooper,** general manager.

Cooper

One of the country's acknowledged top authorities in the field of silica gels and silicates, Dr. Cooper directed the development of the unique new continuous process now producing silica gel and other silicas at the company's new plant in Butler, N. J.

A graduate of University of Tennessee, Dr. Cooper received his doctorate at Michigan State University in 1933. He has been Manager of Engineering Research and Development for Davison Chemical Corporation, and served in similar capacities with Pilot Engineering Company and Chemecon Corp. Well known also in the field of education, Dr. Cooper headed the Departments of Chemical Engineering at University of Denver, Bucknell University, and Pratt Institute, and served as Chairman of the Bucknell Research Council.

Dr. Cooper is a member of American Chemical Society, American Institute of Chemical Engineers, American Society of

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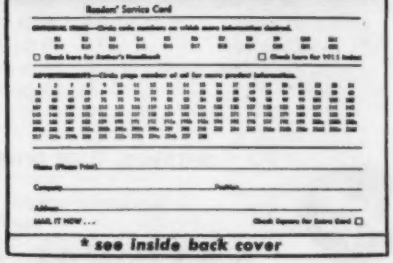

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Now available at no increase in price—anhydrous U.S.P. sodium nitrite in an exclusive time and labor saving *flake* form! For the first time you can get anhydrous sodium nitrite that will dissolve rapidly, as well as store without caking. This new SOLVAY product is now packed in 400-lb. fiber drums as well as 100- and 400-lb. steel drums and 100-lb. bags to meet your individual needs.

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Please send me:
☐ Inspection sample of SOLVAY flake Sodium Nitrite.
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Graham multi-stage ejector capable of sustaining these low absolute pressures

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Through constant and intelligent research, Graham has refined the steam and gas propelled ejector until some would say that we had reached the ultimate—from our viewpoint, not so—we intend to go further. Our progress cannot halt—and to any industry that has a need for this exclusive equipment, we are prepared to demonstrate our guarantees.

We invite you to submit your problem to our Engineering Department without obligation and learn the economies and many advantages of the Graham Ejector for absolute pressures that are practically nil.

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Suppliers . . .

Mechanical Engineers, Electrochemical Society, American Society for Engineering Education, and American Management Association.

Further information available from Douglas Williamson, Amerace Corporation, 93 Worth Street, New York 13, N. Y.

PETROLITE CORP. has added **Sidney B. Ring** to its Patent and Trade Mark staff as patent attorney. He will be located in the new Petrolite research facility at Webster Groves, Mo.

Ring

Before joining Petrolite, Ring was affiliated with General Electric as a patent attorney. He also was a research chemist with American Cyanamid Co. at Stamford, Conn. He served for two years as patent examiner in the U. S. Patent Office in Washington, D. C.

Ring holds an M. S. degree in chemistry from Tufts College, Boston, and an L.L.B. degree from Georgetown University.

THE BABCOCK & WILCOX CO. has announced that **John J. McDermott,** formerly assistant manager of production at the company's Barberton, Ohio, works, has been named production manager. His appointment fills the vacancy created by the transfer of **H. G. Lane** to the Barberton works Manufacturing Engineering department.

HAVEG INDUSTRIES, INC. has announced the acquisition, as a wholly owned subsidiary, of the Reinhold Engineering and Plastics Co., Inc., Norwalk, Calif.

By the terms of the acquisition, Haveg acquired the Reinhold assets and assumption of certain liabilities for an undisclosed sum of cash, 4845 shares of Haveg common stock and options for Reinhold directors to subscribe to 950 additional shares of Haveg.

INTERNATIONAL NICKEL CO.'s Richard B. Kropf has been appointed supervisor of development activities in the automotive industry. This was announced by **Donald J. Reese,** assistant manager of the Development and Research division of The International Nickel Co., Inc. Kropf succeeds **E. J. Hergenroether,** who has retired, and will continue to make his head-

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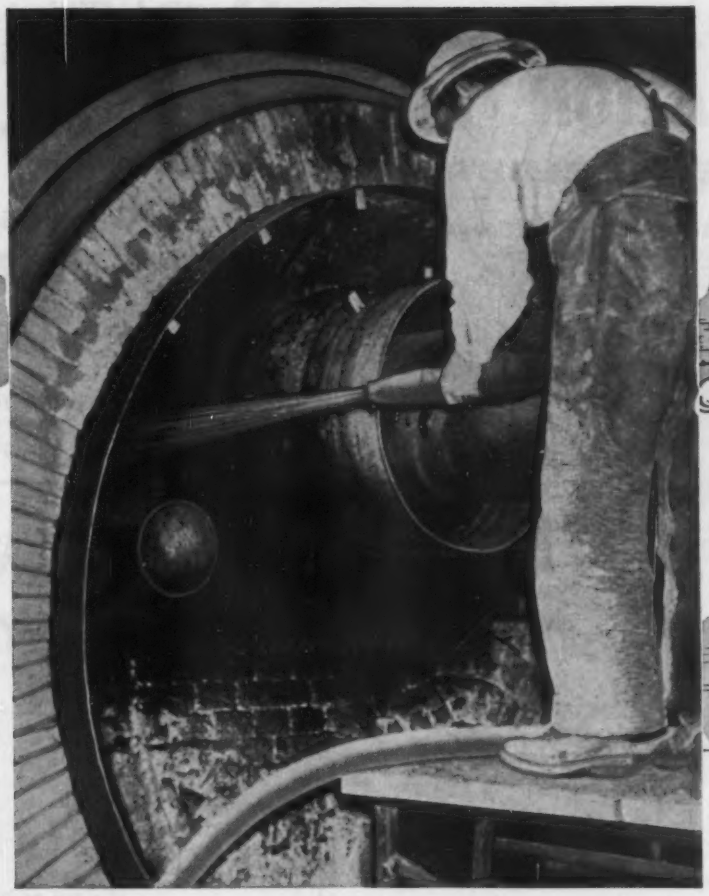

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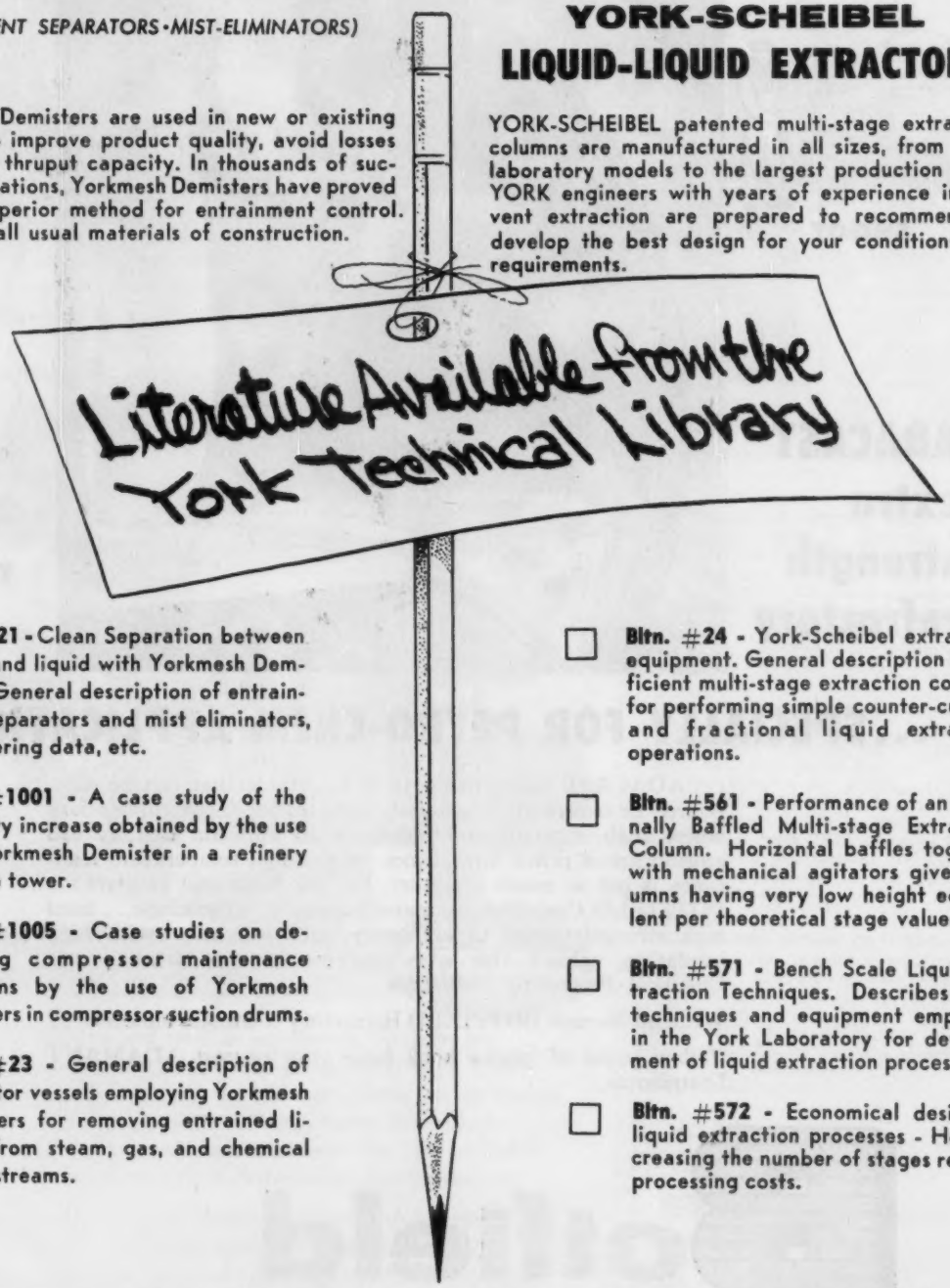
YORKMESH Demisters are used in new or existing equipment to improve product quality, avoid losses and increase thruput capacity. In thousands of successful installations, Yorkmesh Demisters have proved to be the superior method for entrainment control. Available in all usual materials of construction.

Practical, Efficient and Economical

SOLVENT EXTRACTION with YORK-SCHEIBEL LIQUID-LIQUID EXTRACTORS

YORK-SCHEIBEL patented multi-stage extraction columns are manufactured in all sizes, from small laboratory models to the largest production units. YORK engineers with years of experience in solvent extraction are prepared to recommend or develop the best design for your conditions and requirements.



☐ **Bltn. #21** - Clean Separation between vapor and liquid with Yorkmesh Demisters. General description of entrainment separators and mist eliminators, engineering data, etc.

☐ **Bltn. #1001** - A case study of the capacity increase obtained by the use of a Yorkmesh Demister in a refinery vacuum tower.

☐ **Bltn. #1005** - Case studies on decreasing compressor maintenance problems by the use of Yorkmesh Demisters in compressor suction drums.

☐ **Bltn. #23** - General description of separator vessels employing Yorkmesh Demisters for removing entrained liquids from steam, gas, and chemical vapor streams.

☐ **Bltn. #24** - York-Scheibel extraction equipment. General description of efficient multi-stage extraction columns for performing simple counter-current and fractional liquid extraction operations.

☐ **Bltn. #561** - Performance of an Internally Baffled Multi-stage Extraction Column. Horizontal baffles together with mechanical agitators gives columns having very low height equivalent per theoretical stage values.

☐ **Bltn. #571** - Bench Scale Liquid Extraction Techniques. Describes basic techniques and equipment employed in the York Laboratory for development of liquid extraction processes.

☐ **Bltn. #572** - Economical design of liquid extraction processes - How increasing the number of stages reduces processing costs.

We invite you to see our equipment at the Chemical Exposition, Booth No. 69.

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YORK PROCESS EQUIPMENT CORP.
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Suppliers . . .

quarters in Inco's Detroit technical field section office.

Kropf will devote his attention to the engineering materials used in the construction of all types of civilian and military vehicles, in all producing centers in the United States.

Kropf joined International Nickel in September, 1945, and three months later was placed in charge of the newly opened Cincinnati technical field section. In 1951, he was transferred to the Detroit technical field section.

Before becoming associated with Inco, Kropf was district sales manager for New England for Copperweld Steel Co., of Warren, Ohio.

BLAW-KNOX CO. has promoted **Virgil J. Hostler** to eastern district engineer of the company's Chemical Plants division. He will be located in New York City with responsibility for division sales activities in Eastern New York, Northern New Jersey and New England.

Hostler

Hostler has been associated with Chemical Plants division since 1941 except for wartime service as an officer in the United States Navy. At Blaw-Knox he has served as a design engineer and project manager in the engineering and construction of plants for the chemical, nuclear, petroleum and other process industries. He holds degrees in naval science and mechanical engineering from Tufts College.

PERKIN-ELMER LTD., a manufacturing and research development subsidiary has been formed in England, it was announced recently by **Richard S. Perkin,** president of the Perkin-Elmer Corp.

The new company has purchased a factory in Beaconsfield, near London, and has opened a sales office in London to be managed for the time being by P-E's

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Need Engineers - Technical Personnel? Try a Classified Ad in Petroleum REFINER.

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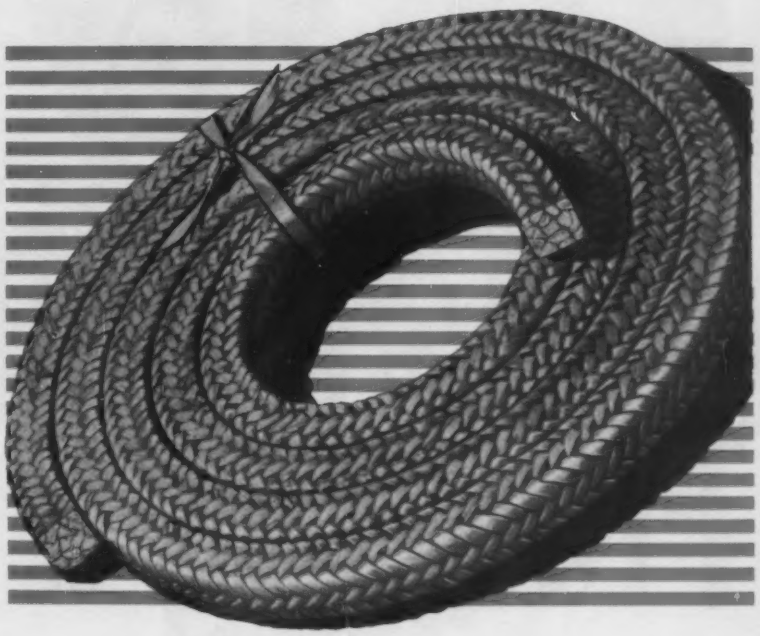
Belmont braided TEFLON



a positively corrosion-resistant compression-type packing

Belmont braided TEFLON Yarn, No. 3085, and braided TEFLON ribbon, No. 3055, combine the complete corrosion resistance of pure du Pont TEFLON—impervious to acids, caustics, oxidants and solvents—with the rugged mechanical structure of Belmont's unique CRISS-CROSS Braid.

A revolutionary departure from conventional braided constructions, the strands in this braid criss-cross from the surface, diagonally through the body of the packing—each strand becoming an integral part of the whole.

Result—a packing that will outlast other type packings many times over in corrosion service. That can't be eaten up by chemicals. That won't ravel, wear through or slough off.

Available in coil and reel form and in ring form with open-cut square joints.

Also available in TEFLON-impregnated white and blue African asbestos.

Ask your Belmont Distributor

Such leading Packing Distributors as:

Mineral Products Company in St. Louis, Missouri and **Peerless Supply Company in Shreveport, Louisiana**

are ready to serve you promptly and helpfully, wherever you are.

The Belmont Packing and Rubber Co., Butler & Sepviva Sts., Phila. 37, Pa.

BELMONT

exclusive
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construction

Prevents Freezing of

OCECO V-130 Conservation Regulators

Positive flexing action of pliable cold and heat resistant membrane, held under tension, peels off icy formations without exceeding set pressures.

NEVER A REPORTED CASE OF VALVE FREEZE-UP

Oceco V-130 Conservation Regulators bring never before secured economy and dependability to the conservation of volatile products stored in cone, round, flat, lifter or expansion roof tanks. Our exclusive pressure balanced construction prevents freeze-ups and protects the tank from excessive pressure and vacuum even under the most severe weather conditions. These regulators prevent vapors from escaping at less than operating setting and **provide greater flow capacity, size for size, and pressure for pressure,** especially at low pressures, **than ever before available.** Write for Bulletin No. 522. It gives full details!

PRESSURE BALANCED CONSTRUCTION. Tank pressures exerted on both sides of the pliable heat and cold resistant membrane keep membrane always under tension; —assuring tight seating fully up to operating setting— and positive flexing action that peels away icy formations preventing freeze-ups.

EXCLUSIVE OCECO FEATURE SAVES YOUR VAPOR DOLLARS!

THE JOHNSTON & JENNINGS CO.

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Suppliers . . .

European sales subsidiary, Perkin-Elmer A. G.

A. R. Gilson, formerly executive director of the University Chemical Laboratories, Cambridge University, is managing director of Perkin-Elmer Ltd. In addition, a panel of British scientists has been formed to serve as an advisory committee for the new subsidiary.

BECKMAN INSTRUMENTS, INC., has appointed **Donald A. Strauss** to the newly-created position of director of employee relations. Strauss is responsible for development and administration of company policies governing wage and salary, retirement, group insurance, supervisory training and related employee programs.

Strauss

Prior to joining Beckman in 1952, Strauss was assistant director of industrial relations for Douglas Aircraft Corp., Santa Monica, Calif. He holds a B.S. degree in economics from Stanford University and an M.S. degree in industrial relations from Cornell.

Strauss has taught employee relations courses at UCLA and Whittier College.

MINNEAPOLIS-HONEYWELL REGULATOR CO.'S Industrial Division has announced a realignment of sales activities to keep pace with expansion of its Systems Engineering group. Two new sales divisions, eastern and western, have been set up, with **J. T. Teed** in charge of the former in Philadelphia and **T. W. Tracy** heading the latter in Los Angeles.

Teed joined Honeywell as an industrial salesman in Tulsa in 1951 following graduation from Texas A. & M. He had been manager of the Tulsa branch office since 1954.

Tracy, a graduate of California Institute of Technology, was a west coast member of Honeywell's rocket and missile team prior to his present assignment. He joined Honeywell in 1949 as an industrial salesman in San Francisco and later was area supervisor for the Transistor Division in Los Angeles.

WESTON ELECTRICAL INSTRUMENT CO. has appointed **Richard E. Love** manager of Recorders-Controllers Sales. Weston is a subsidiary of Daystrom, Inc. A graduate mechanical engineer from New York State Maritime College, Love also holds an associate degree in marketing from Hofstra. Prior to his association with Weston, Love was sales manager of the Control Valves division at W. S. Rockwell Co.

PFAUDLER PERMUTIT, INC., met in Rochester and elected the following officers for the newly merged organization:

Chairman of the Board, Henry W. Foulds; vice chairman of the board, Ranlet Miner; president, Mercer Brugler; executive vice president, D. A. Gaudion; senior vice president, E. Geisinger; vice president, H. L. Beohner; vice president, C. Birch; vice president, G. C. Calvert; vice president, G. N. Proctor; vice president, E. A. Sanford; vice president, D. J.

EXCLUSIVE WITH TIDEWATER DELAWARE CITY REFINERY—
141 DUCON CYCLONES INSTALLED FOR CATALYST RECOVERY

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DUCON CATALYST RECOVERY CYCLONES

Recovery of valuable catalyst in regenerator and reactor systems makes a big difference in the efficiency and costs of oil refining. Ducon Type SDC Cyclones, with the exclusive helical inlet feature, have proved themselves the world over for their dependable high operating effectiveness, and maximum catalyst recovery for constant reuse.

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FLUID CATALYTIC CRACKING • FLUID COKING
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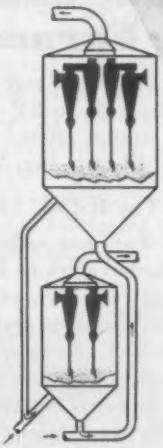

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for Better
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THE COMPLETE LINE
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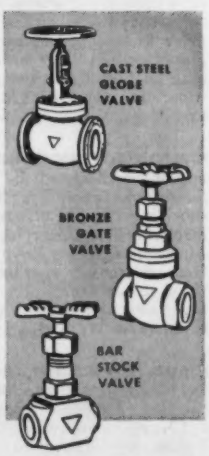
Created by R-P&C—made and sold exclusively by R-P&C...Electric Furnace Iron Valves

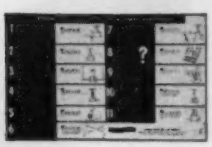
Electric furnace iron—introduced exclusively in R-P&C Valves—provides a high quality cast iron that meets the exacting requirements for pressure castings. Melted and refined under closest metallurgical supervision, R-P&C Electric Iron has physical properties *far exceeding the minimum standards* to which they must conform. It has a balanced chemical composition and a tough, dense body structure; and, it is more resistant to corrosion. All cast iron parts of R-P&C Valves are made of this Electric Furnace Iron.

Shown above is **Fig. 625**, a general service valve which is particularly applicable where full, unobstructed flow is desired. This type, available in bronze-trimmed or all-iron style, either flanged or screwed, is made in fifteen sizes, from 2″ to 24″—and is typical of the better values offered by the entire line of R-P&C Electric Iron Valves.

The R-P&C Line is Complete

The R-P&C line embraces gate, globe, angle and check valves in bronze, electric furnace iron and cast steel, and forged steel; all in a wide range of sizes, styles and pressure classes. Also, R-P&C offers specialties such as Lubrotite gate valves, bar stock valves, asbestos-packed cocks, cast steel fittings and pressure-seal cast steel valves. Order through your nearby R-P&C Distributor. For complete catalog, write our Reading office.





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"How to Protect Your Valves"
Installation pointers, operating tips, clues to longer valve life. They are all on this 22″ x 17″ wall chart. Write for your free copy.

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Saunders; treasurer and assistant secretary, R. A. Ogden; auditor, H. O. Eckhardt; secretary and assistant treasurer, H. W. Krase; controller, W. G. vonBerg; assistant secretary, assistant treasurer, division controller, A. F. Bogle; assistant treasurer and assistant secretary, A. E. Marciante; assistant secretary, R. VanIderstine; assistant secretary, E. W. Zoller.

The following Pfaudler Permutit executive committee was also elected at the meeting: Mercer Brugler, chairman; Claude Birch, H. W. Foulds, D. A. Gaudion, E. E. Geisinger, Ranlet Miner, and G. N. Proctor.

Robert VanIderstine, Pfaudler assistant secretary, will be established in Permutit's New York Office as assistant to board chairman, **Henry W. Foulds.**

TUBE TURNS OF CANADA, LTD., has appointed **Gordon A. Rose** as sales representative at its new Montreal office.

Rose

The new office—at 645 Lindsay Avenue, St. Laurent, Quebec—will provide expanded sales services in Quebec and the Maritime Provinces.

A native of Montreal, Rose joins the Tube Turns marketing staff after 25 years of sales and administrative experience in the industrial piping field with various Canadian firms. He attended Loyola College of Montreal.

ROBERTSHAW-FULTON CONTROLS CO., has changed the name of its Fielden Instrument Division to the Instrument Division, **Thomas T. Arden,** president, announced. The division is located in Philadelphia.

Fielden Instrument Corp. was acquired in 1951.

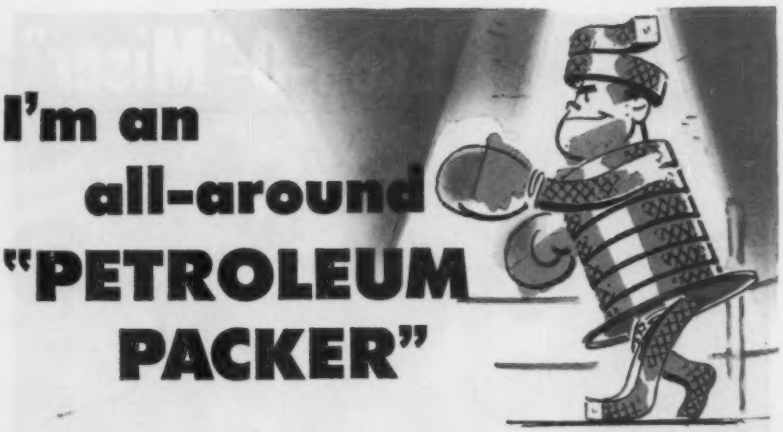
FOSTER WHEELER CORP., has opened an office in the Vance Building, 3rd and Union, Seattle.

The new office will be under the supervision of **S. P. Trewin,** district sales manager, and will serve Idaho, Montana, Oregon and Washington.

TRACERLAB INC.'S Western division, Richmond, Calif., has appointed **Paul Byrne** sales manager. The conversion of this entire facility recently into a reactor monitoring instrumentation and service facility was recently begun and it is undertaking the development, manufacture and sale of reactor instrments and services both in the United States and abroad. Byrne will be responsible for the sale of these products as well as some other specialized items which will be sold by the Western Division. He was formerly Western district sales manager.

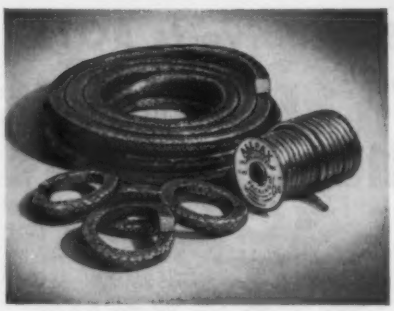
GARDNER-DENVER CO., has acquired 30 acres of undeveloped land near Derby, Colo., that will serve as a site for expansion of its Denver division. The land is adjacent to the mainline of the Union Pacific Railroad near the intersection of East 96th Ave., approximately six miles north of the Denver city limits.

C. H. Rieman, vice president and gen-



I'm an all-around "PETROLEUM PACKER"

Petroleum service separates the men from the boys in the packing field—but you can count on Allpax Packings for this rugged service. They're the result of extensive laboratory research in the development of suitable packings for service against distillates and petroleum products. Recommended for use on centrifugal and rotary pumps, valve stems, swing joints and similar pumping equipment.



Style No. 14 – For regular petroleum service. Excellent against gasoline, light and heavy oils, benzol, toluol, etc. For temperatures up to 550 degrees F. Compounded of long asbestos fibres, fine flakes of graphite, and a special bonding compound containing an oil-resistant lubricant.

Style No. 13 – For extremes in high and low temperatures.

Style No. 30 – For use against petroleum products at high temperatures and pressures. A very dense packing, made by braiding jackets of asbestos yarn over a center core of pure asbestos content. The jacket is treated with a special heat-resistant compound. The outer jacket is lubricated with a coating of graphite.

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SEND FOR OUR NEW CATALOG — TODAY!

A complete line of packing, tools, gasket materials. Ask for dealer information and price schedules.

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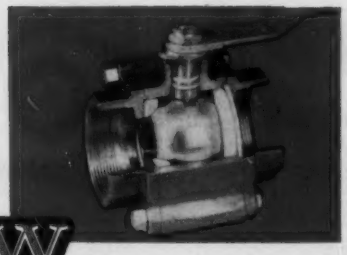
Worcester's New Econ-O-"Miser" Ball Valve* is BOTH

VALVE and UNION

This great new advance in valve design can mean substantial savings for you. Its unique construction makes the Econ-O-"Miser" both ball valve and union in a line whether the application be original equipment, in-plant maintenance or process lines.

The costs of a union and installing it are eliminated, resulting in tremendous savings when the number of ordinary valves and unions in even a small installation is considered. Add to this the longer operating life of the Econ-O-"Miser", the time and materials savings of *in-line maintenance*, and you get performance unmatched by *any* valve at *any* price.



The Econ-O-"Miser" is available in Bronze, Aluminum, Aluminum Bronze, Forged Carbon Steel, Stainless Steel types 303 and 316. Seat and seal materials available: Teflon, Buna-N and Neoprene (others available on request.)

The many combinations of body and seat seal materials allow handling of exceptionally wide range of media.

Other Outstanding Features

- Compact for ease of installation
- Positive leakproof shut-off
- **In-line maintenance** permits quick, easy inexpensive repairs
- Two-way flow allows application of pressure or vacuum to either side of valve
- Quarter turn operation — readily adaptable to remote control
- Visual determination of OPEN — CLOSED positions — No manual check needed
- Round flow through the valve — minimum pressure loss and turbulence
- "Wiper-action" of resilient seat against ball eliminates abrasive wear due to foreign materials in media . . . assures leak-proof seal . . . long operating life

* Pat. Pending

Write for full particulars

WORCESTER VALVE CO., Inc.

15 PARKER STREET WORCESTER, MASS.

Ball, Gate and Needle Valves

Suppliers . . .

eral manager, Denver division, said present plans call for erection of a factory on the new site to house the division's forging facilities. In addition to purchasing new equipment, the forging equipment now located at Gardner-Denver's present plant will be moved to the new location. A new building to house the boiler equipment needed to run the forging hammers at the new property will also be constructed.

JONES & LAUGHLIN SUPPLY DIVISION, Tulsa, has announced the recent move of the firm's local oilfield supply store to its new home at 707 East F Street, Access Road South.

The new prefabricated structural steel building has a masonry front of buff brick with a pink stone pylon and planters. The marquee, window and door frames are aluminum. The 5600 square foot building houses a storeroom, warehouse, store office, three sales offices and a pump shop. A 3200 square foot overhead dock above the storeroom and offices gives the firm a total of 8800 square feet of useable floor space.

Personnel assigned to the Casper store are **Glenn E. Best,** assistant district sales manager, South Rocky Mountain district; **Curtis L. Sample,** local store manager; **Carl J. Watson,** machinery engineer; **Jack S. Bastian,** city salesman; **Hanson L. Rikard and Lloyd V. Page,** field salesmen; **Jack W. Payne,** sales trainee; and storemen, **Jimmy A. Rogers, Garland R. Cain, William T. Fleming** and **Otis P. Johnson.**

The Casper store is under the over-all supervision of **D. H. Carson,** district sales manager, South Rocky Mountain District.

THE WESTON ELECTRICAL INSTRUMENT CORP., Newark, N. J. has relocated its instrument service division in a new building at Polk St. and Jefferson Ave., off highway 22, Union, N. J. Weston is a subsidiary of Daystrom, Inc. This move will provide the service department with greatly enlarged and more efficient quarters, thus insuring prompt customer service. All shipments and communications relating to instrument service should be forwarded direct to the new address.

WORTHINGTON CORP. has announced the election of **William A. Meiter** to the newly created post of vice president Employee Relations and Organization Development. Meiter, formerly general marketing manager, has been with Worthington since 1927.

Meiter joined Worthington as a graduate student engineer after receiving his mechanical engineering degree from Ohio State University. He served as a sales engineer in the company's Cleveland district sales office from 1928-1938, manager

REFINER

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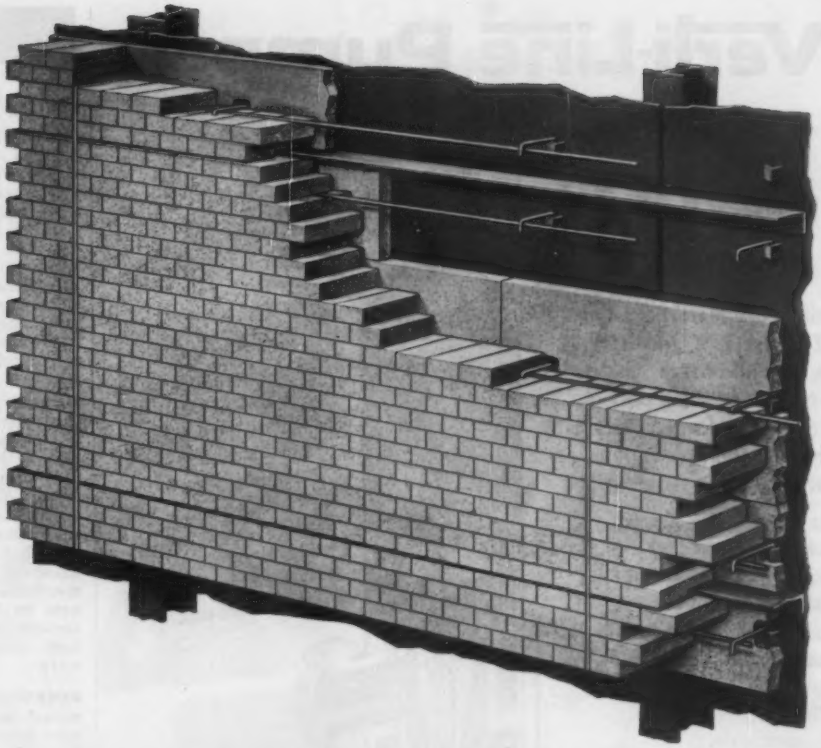
RESULTS



B&W Insulating Firebrick sectionally supported wall construction, horizontal rod-type anchoring

Can this construction cut your costs?

Simplified design and lower material costs in initial construction, ease of installation and maintenance, reduced downtime and economy of operation—these are the benefits of this lightweight insulating firebrick construction.

Here's what lightweight means. Compared with dense fireclay refractory materials that weigh from 125 to 140 lb per cu ft, lightweight insulating firebrick weigh approximately 26 lb per cu ft for B&W's 2000 degree brick. This difference provides two major advantages: (1) mechanical, which largely affects design and construction, and (2) thermal, which saves in maintenance, downtime and operation.

Savings in design and construction

The use of lightweight IFB simplifies engineering requirements and reduces costs. A minimum of detailing is needed, since the design is engineered around one standard shape — a feature of B&W IFB constructions.

Material requirements are simplified, too. B&W IFB can be tailor-cut, drilled or shaped as necessary, eliminating the need for costly special fired shapes, and the delays in obtaining them. Typical sections, such as burner openings, observation ports and tube supports, can be cut and shaped on the job in minutes, using ordinary woodworking tools.

Substantial savings are possible in structural steel, since insulating firebrick roof and wall constructions are lighter. In locations with soil of poor load bearing capacities, this lightweight may also result in reduced foundation costs.

These savings, coupled with B&W's engineering and service facilities available during the design phase, mean lower initial costs.

Savings in maintenance, downtime and operation

Lightweight IFB offer a major thermal benefit—they store and conduct less heat. Heavy refractories retain heat; in the event of forced shutdown, they can cause burn-out of expensive alloy tubes, where used. The low quantity of heat stored by B&W IFB can be quickly dissipated, thus protecting these expensive tubes.

Further, this low heat storage permits faster heating and cooling. This means quicker access to the furnace in the event of emergency shutdown. Your maintenance crew can get in the furnace sooner and get it back on stream faster.

Supplied from nearby warehouses

With the use of simplified IFB constructions, refractory repairs can be quickly and easily accomplished with standard shapes from a nearby warehouse. This eliminates costly delays in obtaining special shapes.

Anchoring devices, too, are simplified. Since there are no expensive special castings in B&W IFB constructions, carbon steel or low alloy rods can be used. These are generally available from any local steel warehouse.

Increased efficiency

Generally, the lighter a firebrick the better an insulator it is. Since B&W IFB are the lightest insulating firebrick made, they are the most efficient insulators. Per inch of thickness, B&W IFB provide more insulation than any other refractory material. The result is that for walls of equivalent thickness less heat is lost with B&W IFB. Casing temperatures are lower, thus improving working conditions. This means increased efficiency and reduced operating costs.

R 939

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

For more data on advertised products, use Readers' Service Cards, last page.

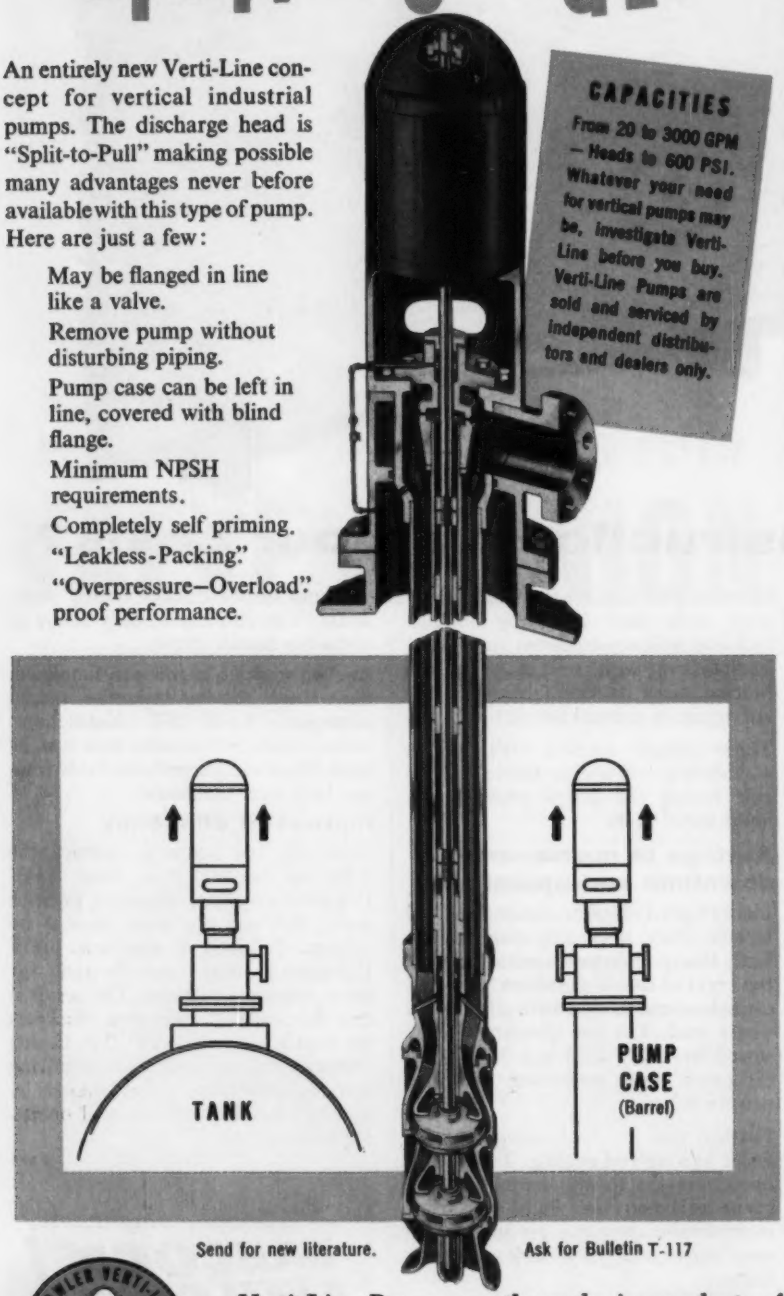
Verti-Line® Pumps *are made* "SPLIT-TO-PULL"

An entirely new Verti-Line concept for vertical industrial pumps. The discharge head is "Split-to-Pull" making possible many advantages never before available with this type of pump. Here are just a few:

- May be flanged in line like a valve.
- Remove pump without disturbing piping.
- Pump case can be left in line, covered with blind flange.
- Minimum NPSH requirements.
- Completely self priming.
- "Leakless-Packing."
- "Overpressure—Overload" proof performance.

CAPACITIES

From 20 to 3000 GPM — Heads to 600 PSI. Whatever your need for vertical pumps may be, investigate Verti-Line before you buy. Verti-Line Pumps are sold and serviced by independent distributors and dealers only.



Send for new literature. Ask for Bulletin T-117

Verti-Line Pumps are the exclusive products of

LAYNE & BOWLER PUMP COMPANY

general offices and main plant

2943 VAIL AVENUE • LOS ANGELES 22, CALIFORNIA

Suppliers . . .

of the Buffalo district sales office from 1938-1950, and central regional manager from 1950-1955, when he was appointed general marketing manager.

He will be succeeded by **A. William Fraser,** commercial vice president in charge of the district sales offices at Chicago, Denver, Kansas City, St. Louis, and Minneapolis. Fraser completed Worthington's graduate student engineer training course after graduating from Northeastern University in 1929. He served successively as sales engineer, Chicago district manager, and general European manager before his appointment to the midwest region.

NORTON CO., in its booth at the 26th Exposition of Chemical Industries (booth 1289), will feature the products of its newly formed Electro-Chemical division. The Exposition is being held at the New York Coliseum December 2 to 6.

Also featured will be high temperature refractory products essential to the chemical industries. These include produces made of silicon carbide, fused alumina, magnesia and zirconia. Among the products to be shown are catalyst carriers, ceramic porous plates and tubes, linings for high temperature reactors and laboratory ware.

ROCKWELL MANUFACTURING CO. has promoted five leading sales officials to new sales management posts in Pittsburgh. The five—all of whom have been named assistants to Herman Gottwald, recently appointed assistant vice president and product manager-Nordstrom valves—include:

Thomas I. Stacy, former Houston district sales manager, now assistant product manager-transmission line valve sales.

Richard E. Miller, former gas sales supervisor in the New York district, now assistant product manager-valve lubricants and accessories.

Jack W. Harris, former Houston senior sales engineer, now assistant product manager-refinery and chemical valve sales.

John R. Applegate, former Chicago senior sales engineer most recently attached to the Detroit branch office, now assistant product manager-utilities valve sales.

Clyde H. Chronister, former Tulsa senior sales engineer, now assistant product manager-production valve sales.

THE BABCOCK & WILCOX CO. Tubular Products division has named **John F. Beck** metallurgist supervisor of technical service. His duties will include liaison on technical matters between the Tubular Products division and its customers and the industry.

Also, **Clark P. Church** has become metallurgist supervisor of process development, with responsibility for supervising development of mill processes relating to new materials and methods.

Dr. John F. Ewing has been appointed metallurgist supervisor of research, with responsibility for the supervision of research studies and alloy development. He

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M-S® CRACKING CATALYSTS
Silica-Alumina (13% and 25%)
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REFORMING CATALYSTS
Catforming Catalyst—Silica-Alumina-Platinum
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Chromia-Alumina

POLYOLEFIN CATALYST
Chromia-Silica-Alumina

DEHYDRATING AGENT
Silica Gel

ANTIOXIDANTS
Dav-Ad 101 (alkylated phenol)
Dav-Ad 102 (alkylated phenol in toluene)

Complete laboratory facilities and technical assistance

DAVISON CHEMICAL COMPANY
Division of W. R. Grace & Co.
101 North Charles Street, Baltimore 3, Maryland

SALES OFFICES: Chicago, Ill.; Houston, Tex.; New York, N. Y.; Baltimore, Md.; San Francisco, Calif.; Tulsa, Okla.
In Canada: Davison Chemical Company Ltd., Toronto.

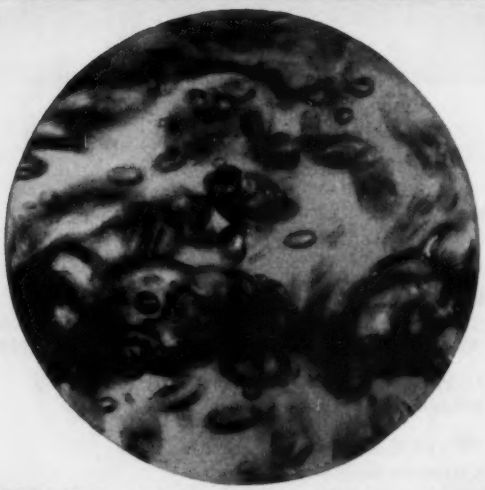
For more data on advertised products, use Readers' Service Cards, last page.

BEFORE CONCENTROL—Foaming of highly alkaline solution in glass test cylinder.

HERE'S PROOF:

CONCENTROL

CONTROLS FOAM AND BOILER WATER CARRY-OVER



AFTER CONCENTROL—Same solution after addition of 12 ppm of Concentrol Antifoam.

Where boiler water carry-over is caused by foaming due to high alkalinity and high proportion of dissolved solids in the water, Concentrol provides a low cost, effective method of chemical treatment and control. Supplied in liquid, powder or briquet form—to be fed continuously or in slugs to boilers—Concentrol is essentially a surface agent that causes breakdown of bubble film to prevent foam formation. Formulations of Concentrol can include organic sludge conditioning agents and other water treatment chemicals for boiler treatment as well as antifoam. Fast acting and resistant to hydrolysis or breakdown under normal boiler temperatures and pressures. Eliminates need for costly pre-treatment of water and high blow-down rate.

Write for NAME OF BIRD-ARCHER WATER TREATMENT ENGINEER NEAREST YOU.

BA 607

BIRD-ARCHER

WATER TREATING ENGINEERS

THE BIRD-ARCHER COMPANY, 4337 N. AMERICAN ST., PHILADELPHIA 40, PA.

New York, Chicago

The Bird-Archer Co. of California, 881 Mission St., San Francisco

Offices also in Canada and Mexico

Suppliers . . .

continues his work as secretary of the company's superheater materials committee.

Thomas M. Krebs has been made metallurgist supervisor of customer service. His functions will include consultations with customers and manufacturing units on the resolution of technical problems.

UNITED STATES STEEL CORP. has appointed **James E. Chenault, Jr.** assistant district manager at Edmonton, Alta., for its Oil Well Supply division. The announcement was made by **W. A. Weir,** Canadian area manager for the division.

Chenault was employed by "Oilwell" in 1948 at the Dallas, Texas, headquarters office and later that year was appointed an auditor. In 1951 he was appointed assistant inventory analyst at Dallas and in 1952 was named coordinator-price regulations. Prior to his present appointment he was pricing coordinator. A graduate of Texas Christian University, Fort Worth, Tex., he served in the United States Navy during World War II.

THE YOUNGSTOWN SHEET AND TUBE CO. has announced the promotion of two officials of its Campbell works at Youngstown. They are:

Ed O. Reese, general superintendent of flat rolled and tubular products, to manager, Youngstown district.

John H. Stone, assistant superintendent, Seamless Tube Mill Finishing department, to general superintendent, flat rolled and tubular products, replacing Reese.

Reese succeeds **J. S. Stanier** as Youngstown district manager. Stanier has retired.

A native of Victoria, Virginia, Reese received his B.S. degree in engineering from the Carnegie Institute of Technology, Pittsburgh.

He joined Youngstown in 1935 as an investigator in the Standards department. In 1947 he was appointed assistant superintendent and was made superintendent in 1954. He was appointed general superintendent of flat rolled and tubular products in December, last year.

Stone is a native of Belmont, Mass.,

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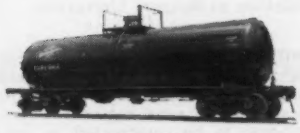
4000 TONS TO KILL A MOSQUITO ?*



ACF-DURADOME *Tank Cars — the finest, modern way to safely ship all types of bulk liquids.*

ACF-Covered Hopper Cars prevent costly contamination, reduce handling costs.

LITTLE does Anophales Quadrimaculatus* know that tremendous forces are at work to cut short his and other insects' annoying, disease-spreading careers. For with each stroke of this 4000 ton press, another flat sheet of steel is accurately formed into the end of a tank car that might carry thousands of gallons of liquid insecticides to all parts of the country. This is one of the many giant-scale operations controlled with "watch-like" precision that make Shippers' tank and covered hopper cars the finest on the rails . . . Your assurance that the products you ship – liquid, powdered, or granulated – are safeguarded in transit.

For bulk shipments that are safe, clean and economical, SHPX is your answer. Our national network of offices and maintenance shops assure peak operating performance of our cars at all times.

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30 CHURCH STREET, NEW YORK 7, N.Y.

SHIPPERS SHPX CAR LINE

Shippers' Car Line is the lessor and exclusive sales agent for ACF-built DURADOME *tank cars.*

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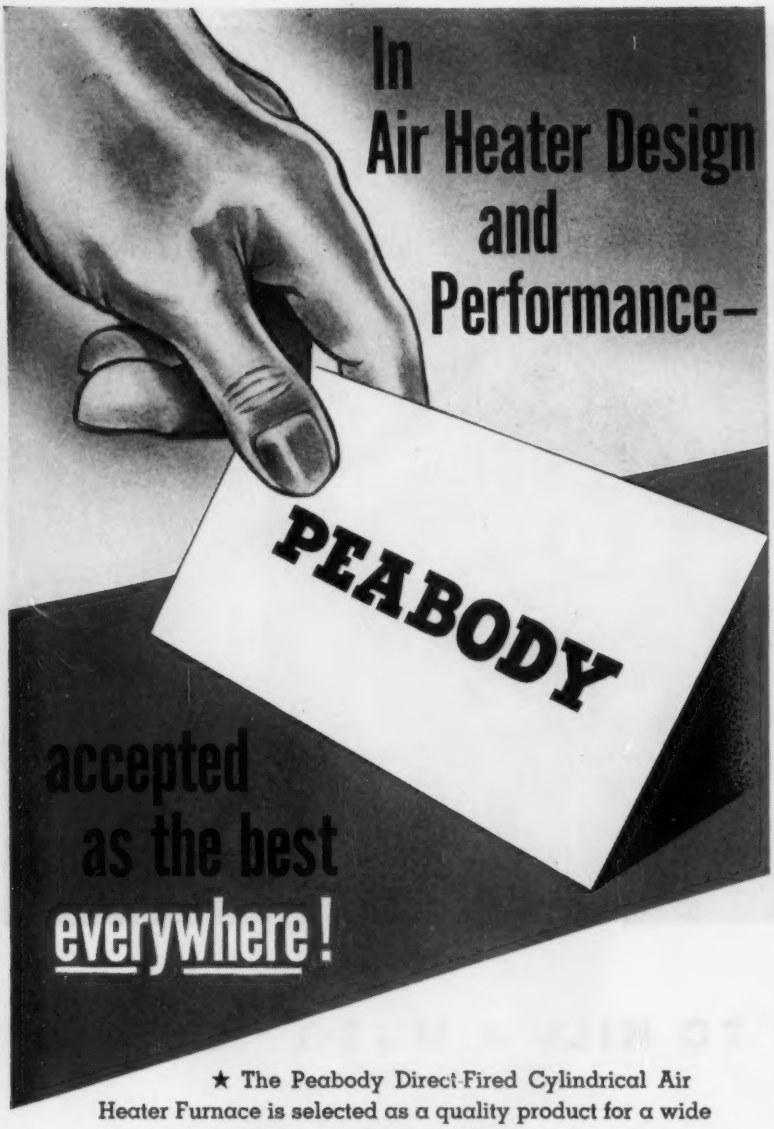
For more data on advertised products, use Readers' Service Cards, last page.



★ The Peabody Direct-Fired Cylindrical Air Heater Furnace is selected as a quality product for a wide range of tough jobs—from 1 million B.T.U./hr. to 350 million B.T.U./hr. liberation, and for pressures from atmospheric to 10 atmospheres.

For catalyst regenerating, spray drying, kiln drying, chemical or food processing and many other processes, Peabody delivers controlled volumes of hot gas, pressurized or unpressurized, over a wide range of outlet temperatures.

Peabody burns standard liquid and gaseous fuels, or special fuels such as liquid carbon bisulphide or hydrogen sulphide gas.

You can depend on Peabody Air Heater Furnaces. Ask the companies that use them—again and again!

PEABODY ENGINEERING CORPORATION

232 MADISON AVENUE, NEW YORK 16, N. Y.

OFFICES IN PRINCIPAL CITIES

PEABODY LIMITED • LONDON, S.W. 1, ENGLAND

7-065

Suppliers . . .

and attended Brown University. He joined Youngstown in 1947 as an industrial engineer.

Stanier joined The Youngstown Sheet and Tube Co. in 1933 as superintendent of the Brier Hill Sheet Mill department. He later served as superintendent of the Cold Strip Mill at Campbell, superintendent of the Hot and Cold Strip Mills and general superintendent of flat rolled and tubular products before becoming district manager.

HOOKER ELECTROCHEMICAL CO., Niagara Falls, N. Y., and **Foote Mineral Co.,** Philadelphia, have jointly announced that they are together exploring possibilities for the development, production and sale of components of high energy fuels. Currently, their interests are confined to lithium perchlorate and ammonium perchlorate, materials which act as oxidizers in fuels for rockets and missiles, but studies may be extended to other high energy fuel components later. The joint announcement is made by **R. Lindley Murray** and **Gordon H. Chambers,** board chairmen of Hooker and Foote.

ALCO PRODUCTS, INC. has affirmed the appointment of **Thomas F. Smith,** New York City as the company's assistant treasurer.

Smith formerly was associated with the New York Trust Co. as an assistant treasurer. In his new position, he will handle financial matters for ALCO and will report to **Herman Press,** the company's vice president of finance.

He joined the New York Trust Co. in January, 1954. Prior to that he held similar duties with the First National Bank of Chicago. Before entering banking, Smith was employed by the Deering, Milliken & Company, Inc., a textile manufacturer, and as a reporter for the *Wall Street Journal.*

He was graduated from Indiana University in 1948 with a B. S. degree in finance and economics, and has done graduate work at the DePaul University Law school, the New York University graduate school of business and the graduate school of banking at Rutgers University.

HEWITT-ROBINS, INC. will move next year from its present North Central regional headquarters at 402 West Randolph St., Chicago, to a new regional office and warehouse to be constructed in the Melrose Park industrial center about 12 miles west of the Chicago Loop.

The new building will be one-story high, of buff brick exterior with a reinforced concrete frame and a poured gypsum roof. It will contain 30,000 square

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PETROLEUM REFINER Subscribers

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Three-point program works for motor oil producers at AMOCO Chemicals

1. **Research**—Petroleum chemists who have made important contributions in the field of additives are engaged in research programs to develop improved new petroleum additives for your use.

2. **Testing**—At AMOCO Chemicals your motor oil formulations are evaluated in one of the nation's top engine-test laboratories. Trained engineers supervise and conduct engine-test and laboratory work.

3. **Technical Service**—Sales engineers qualified by years of experience in this work are ready to help you with laboratory and field-test programs to develop motor oils and other petroleum products to meet your marketing requirements.

Put this three-point program to work. Let AMOCO Chemicals become your resource for petroleum additives. Your inquiry will receive an immediate response.

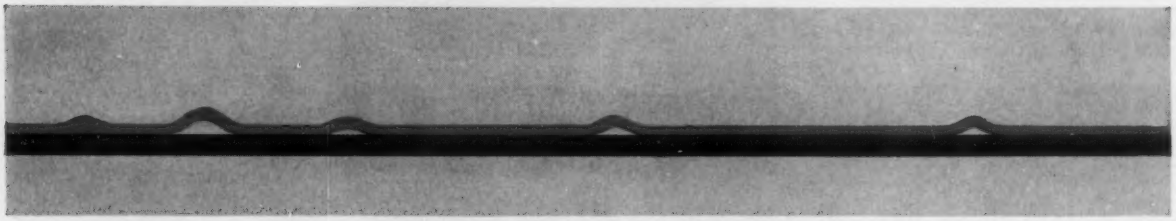
AMOCO CHEMICALS—
A NEW RESOURCE

AMOCO
CHEMICALS
CORPORATION

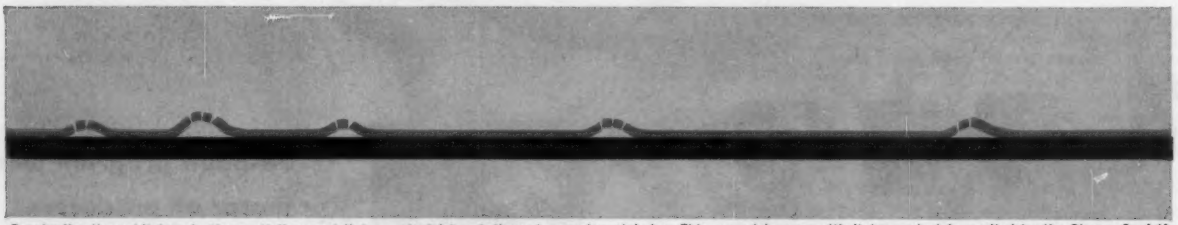
910 S. Michigan Ave. • Chicago 80, Ill.

For more data on advertised products, use Readers' Service Cards, last page.

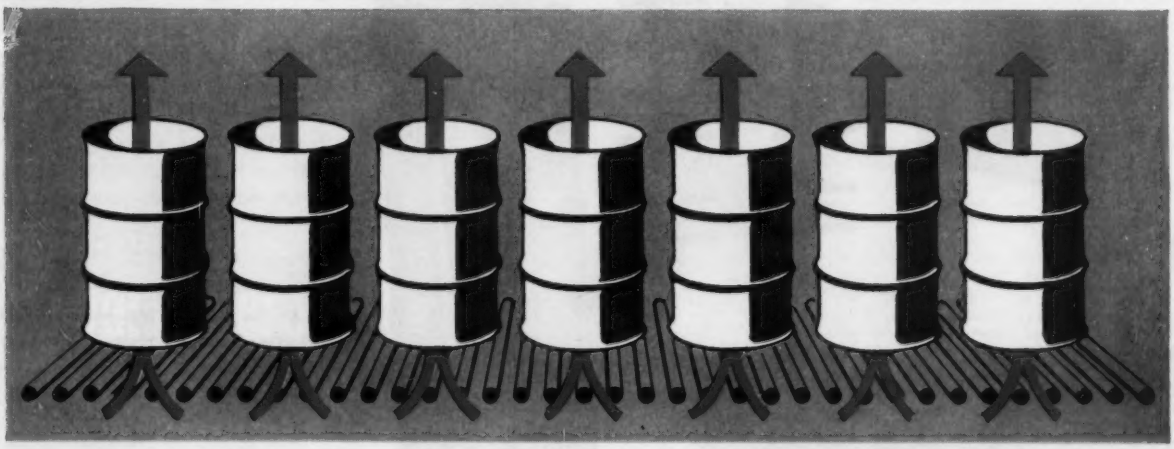
Now! No trace of blisters or pinholes!



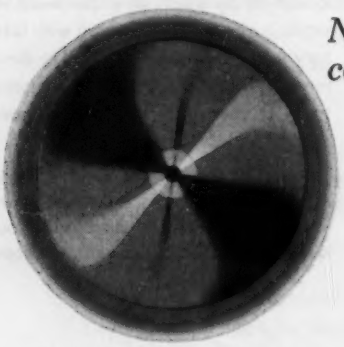
Globules of air or solvents can be trapped in lining material applied to steel drums by the air spray method These expand under heat during the curing process.



Eventually, these blisters in the partially cured lining material break through, causing pinholes. This cannot happen with lining materials applied by the Rheem Centrifugal Spray Process as no air is used, and solvent content is vastly reduced.



And Rheem uniformly applied linings are properly cured by high temperature baking which insures even, free flow of warm air vertically through every drum.



New Centrifugal Sprayer spins off a continuous curtain of finely atomized lining material at a controlled, uniform rate.

New Rheem Centrifugal Spray Process gives you a completely uniform lining, drum after drum after drum!

All surface areas of a drum automatically lined by the new Rheem Centrifugal Spray Process are—*and stay*—completely and uniformly coated.

This new, fully automatic process not only eliminates globs and skips, but blisters and pinholes as well. And Centrifugal Spraying, teamed with the new Rheem Vertical Baking Process, results in a curing job never before equaled!

Only the new Rheem Centrifugal Spray Process gives you: (1) Uniform lining thickness—controlled to within .1 of a mil. (2) Uniform viscosity of lining materials with lower solvent content. (3) Uniform application. There's no air turbulence because there's no air used in the spray and no drum rotation. Spray always travels the same distance to coat all surfaces. Human element eliminated. (4) Uniform curing—thanks to vertical, 3-stage ovens with controlled air flow and temperatures.

YOU CAN RELY ON Rheem WORLD'S LARGEST MAKER OF STEEL SHIPPING CONTAINERS

For full details write: Rheem Manufacturing Co.
Container Division, 1701 Edgar Road, Linden, N. J.

4901 Jefferson Highway • New Orleans 20, Louisiana • 1025 Lockwood Drive • Houston 20, Texas

feet of office and warehouse space. The office area will be air conditioned and the warehouse area will be equipped with a 5-ton overhead crane and other mechanical equipment for the efficient handling of material.

THERMAL RESEARCH & ENGINEERING CORP. has elected **William R. Huguenin** a director it was announced recently by **L. C. Peskin,** president.

Huguenin, who succeeds **John F. Maher,** resigned, is president of Stokes and Smith Co., subsidiary of Food Machinery & Chemical Corp. which owns 50,000 shares of Thermal stock, together with options on 100,000 additional shares of stock. **Benjamin C. Carter,** executive vice president of Food Machinery & Chemical Corp. also is a director of Thermal.

UNITED STATES STEEL CORP. has announced that **Dr. Edgar C. Bain,** assistant executive vice president-operations, has retired after nearly 30 years of service with the corporation.

Dr. Bain began his career with United States Steel in 1928 when he was asked by Dr. John Johnston to head the metallurgical department in the newly-formed research laboratory at Kearny, N. J., in which capacity he served until 1935 when he became assistant to vice president. In 1943 he was named vice president-research and technology of Carnegie Illinois Steel Corp. In addition to retaining this title in United States Steel Corp. upon its reorganization in 1952, Dr. Bain was also appointed chairman of the research policy committee. He assumed his duties as assistant executive vice president-operations on July 1, 1956.

LAFAYETTE STEEL & ALUMINUM CORP., Chicago, has been appointed a distributor for Olin Aluminum, **Sam Gurley, Jr.,** vice president for sales for Olin Aluminum. Olin Aluminum is the trade name for aluminum produced by Olin Mathieson Chemical Corp.

Lafayette Steel & Aluminum Corp., 4100 South Karlov Ave., Chicago, was formerly known as the Lafayette Steel Corporation. The company's name was changed because of its expansion into the sale and distribution of aluminum.

Lafayette was incorporated in 1937 as a wholly-owned subsidiary of Caspers Tin Plate Company, Chicago.

ARMSTRONG CORK CO. has merged the Los Angeles and San Francisco offices of its Insulation division, to form the San Francisco-Los Angeles district office.

John S. Taylor, current district manager of the San Francisco office, has been named district manager for the combined operation. **Mann C. Sweet,** of the Los Angeles office, will serve as branch manager at Los Angeles under Taylor's direction.

Taylor, who graduated from Virginia Military Institute in 1940, joined Armstrong in 1946 after serving in the Armed Forces during World War II. He was appointed district manager at San Francisco in 1953.

Sweet, who graduated from John Brown University in 1941, joined Armstrong in 1947 after serving in the Armed Forces following several years of government work. He has been assigned to the Los Angeles office since 1947.

A. B. Callow, district manager at Los Angeles, is retiring after more than 45 years service with the company. He joined the company in 1912 at Pittsburgh.

ROCKWELL MANUFACTURING CO. has acquired **Ilo-Werke, G.m.b.H.,** a West German manufacturer of two-cycle, air-cooled diesel and gasoline engines, **Willard F. Rockwell, Jr.,** president, announced recently.

Rockwell made the announcement on his return from a 10-day trip to West Germany to review his company's sales program in that country and to discuss with Ilo-Werke officials how the new company will fit in with Rockwell operations. He was accompanied by **Lloyd A. Dixon,** executive vice president.

The German company has its headquarters and principal factory in Pinneburg near Hamburg and also operates a plant at Munich. Ilo-Werke management, headed by **Heinrich Christiansen** as president, will remain the same.

Suppliers . . .

HARBISON-WALKER REFRACTORIES CO. has named **Joseph M. Franz** Philadelphia district sales manager. Franz has been a member of Harbison-Walker's sales organization since 1924, most recently in the Detroit district office.

INTERNATIONAL NICKEL CO., INC., has placed **Robert E. Savage** in charge of the Distributor Sales section of the Nickel department it was recently announced by **Lars S. Larson,** vice-president and general sales manager. In his new position, Savage succeeds the late **E. J. Bothwell.**

Savage joined International Nickel in

Here's Real Proof of the Superiority of Hartzite Plastic Cooling Tower Fans

Since Hartzite plastic was introduced in 1941, one leading producer of petroleum products* has purchased 411 Hartzell cooling tower fans with Hartzite plastic blades. This figure does not include the additional units supplied to this customer by the cooling tower manufacturers who use Hartzell fans on their towers.

What better proof could you ask of the superiority of Hartzite plastic fans than this complete acceptance by one of the largest users of such equipment. Beyond all doubt, Hartzite has proved itself to this customer and to thousands of other cooling tower operators as the fan blade material most resistant to vibration, corrosion, abrasion and mechanical damage.

For complete details on Hartzell fans, and how they can help you cut cooling tower maintenance costs, write today for free Bulletin A-111 or call your nearby Hartzell field engineer.

*Name on request.

HARTZELL Propeller Fan Co.
Division of Castle Hills Corp.
909 Thomas Blvd. Piqua, Ohio

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

December, 1949, as a member of the Ductile Iron section of the company's Development and Research division, and in September, 1956, was transferred to the Nickel department.

Savage holds Ph.D. and M.S. degrees from the Massachusetts Institute of Technology.

Before joining International Nickel, Savage served in an engineering capacity with the Bethlehem Steel Co., the Carnegie Illinois Steel Co. and the Pittsburgh Steel Foundry Corp.

OLIN MATHIESON CHEMICAL CORP. has announced that **Elmer M. Richardson** has joined the company as director of marketing for Olin Aluminum. **Sam Gurley, Jr.**, vice president of sales, Aluminum division, made the announcement. Richardson had been general sales manager of the Refractories division, H. K. Porter Company, Inc., Pittsburgh.

Prior to joining H. K. Porter, Richardson had his own management consulting firm in Philadelphia. From 1945 to 1955 he was associated with the Nice Ball Bearing Co., Philadelphia, as general sales manager. Prior to World War II, he was an insurance broker in Philadelphia.

A native of Philadelphia, Richardson attended the University of Pennsylvania's Wharton School.

OUR
NEW
OFFICE

. . . at 307 East 63rd street
in the Country Club District
of Kansas City, Missouri,
gives us expanded facilities
to serve our clients more
efficiently—and at the same
time offers our employees
more pleasant surroundings.

"In Engineering, it's the PEOPLE that Count"

THE C. W. NOFSINGER CO.

Engineers and Contractors for the Petroleum and Chemical Industries

307 East 63rd Street Kansas City 13, Missouri

UNITED STATES STEEL CORP. has appointed **Robert L. Swank** manager of sales-plastic pipe for National Tube division. The announcement was made by **Robert E. Williams**, National Tube general manager of sales.

At the same time, Williams announced that **Thomas D. Cramer** has been appointed assistant manager of sales-plastic pipe for the U. S. Steel division.

Swank, who will be in charge of the nation-wide sales of National Tube's plastic pipe, succeeds **Robert K. Henderson**, newly-appointed National Tube district sales manager in Philadelphia.

Swank graduated in 1946 from Northwestern University with a B.S. degree in business administration. He joined National Tube's sales training program the same year, and in December, 1946, was assigned to the division's sales office in Detroit. He was transferred to the Chicago District sales office in January, 1953, as a resident salesman stationed in Des Moines.

Cramer, earning an M.S. degree in business administration in 1950 from the University of Michigan, then joined U. S. Steel's commercial research department. He transferred to National Tube's commercial research department in 1953, and was named a sales representative for plastic pipe in 1955.

ROCKWELL MANUFACTURING CO.'S current expansion program in its western Pennsylvania plants has been completed, and remodernization of a portion of its Pittsburgh headquarters is nearly finished, **Willard F. Rockwell Jr.**, president, has announced.

More than 50,000 square feet of manufacturing space, in addition to a new gas meter laboratory, and a new front facade have been added to the DuBois, Pa., gas meter plant. Approximately 27,000 square feet including new engineering facilities have been added to the Uniontown, Pa., water meter plant.

HOOKER ELECTROCHEMICAL CO. has begun construction of the Hooker Research Center on Grand Island, N. Y., it was announced recently by **Bjarne Klaussen**, president of Hooker Electrochemical Co., Niagara Falls, N. Y. The initial facilities will be completed by late 1958 or early 1959. Costing approximately $3.5 million the new Research Center will provide space for about 200 personnel.

The 61-acre site, located near the North Grand Island Bridge, is bounded by the New York State Thruway to the east, Long Rd. to the south, the curving West River Parkway along the west branch of the Niagara River, and Buckhorn Island State Park. The Research Center, accessible from both West River Parkway and Long Rd., will face the river and Navy Island in a scenic setting.

The new Research Center is of modular design and will combine the best features of some dozen modern research centers visited by company officials prior to final formulation of plans. All building areas will be connected and will initially utilize about 69,000 feet of floor space.

H. K. PORTER CO. has announced the appointment of **Thomas J. Gorman** as director of purchases for its Quaker Rubber division. The announcement was made by **George A. Dauphinais**, vice president and general manager.

Gorman has been with Quaker since 1939; for the past 10 years he has been chief chemist. He is a graduate of La

DU PONT *Petroleum Chemicals* NEWS

Number 81 in a Series of Bulletins for the Petroleum Industry

NOVEMBER 1957

New anti-icing additive offers economic advantage to refiners

YOU OUGHT TO KNOW...

JOSEPH G. EVANS is manager of the Petroleum Chemicals Division's San Francisco district, which includes the important northern California refining area near Du Pont's tetraethyl lead plant at Antioch.

Mr. Evans joined the Du Pont Company in December, 1951. He was at first assigned to sales service in the Mid-Continent region with headquarters in Tulsa.

Prior to this he was development engineer for a stoker company in western Pennsylvania, and later organized a company distributing industrial chemicals and specialized lubricants.

Mr. Evans is a graduate of Texas A & M. During the second world war he was an officer in the U.S. Navy, on submarine duty in the Pacific. He was recalled to active duty in 1950 and served two years on a destroyer off Korea. He is a member of the Society of Automotive Engineers, National Sales Executives and the Board of Directors of the San Francisco Sales Executives' Association.

Engine stalls caused by carburetor icing have become more annoying to motorists in recent years. This is because automatic chokes and transmissions on newer cars make it difficult to prevent stalls by "gunning" the engine, especially in heavy traffic. Power brakes and steering, less effective when the engine stops, make stalls a still greater problem.

THIS DEMONSTRATION DEVICE clearly shows the causes and prevention of carburetor icing. It consists of a small ice-cooled air intake and a 1.6-horsepower engine connected to it by a transparent manifold. When unprotected gasoline is drawn through the tube, ice visibly forms and causes the engine to stall. But the addition of DMF to the gasoline maintains constant, ice-free carburetion.

More and more refiners are now using additives in gasoline to prevent carburetor icing. One of the most effective is Du Pont DMF (dimethyl formamide) antistall additive. It is economical; only a little is required for protection. In many instances, less than two milliliters of DMF per gallon of gasoline are needed to keep carburetors ice-free. Therefore DMF is economical to ship, to store and to add to gasoline.

(Continued)

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT *Petroleum Chemicals* NEWS

CONTINUED *Anti-icing additive*

Marketing advantages

Since motorists are becoming increasingly aware of carburetor icing and the stalling annoyance it causes, you can profitably feature your use of DMF in advertising and promotion campaigns.

To help you capitalize on the motorist benefit of DMF, we have prepared a number of sample ads, poster designs and sales aids (shown above). These dramatize the anti-stalling advantage of gasolines containing DMF. The ideas can be incorporated in your advertising.

Just drop us a line or get in touch with any Petroleum Chemicals Division representative.

In 1956 Du Pont spent $48,000,000 in Texas

During 1956, more than 2,000 Texas firms sold over $30,200,000 worth of goods and services to Du Pont plants in Texas. During the same year, Du Pont payrolls in Texas amounted to more than $17,700,000.

The purchases included raw materials used in chemical manufacturing . . . natural gas, butadiene, propane, ammonia, chlorine, caustic, ethylene, cyclohexane, lubricating oils, and nitric, acetic and sulfuric acids.

Small business concerns supplied many of the more unusual items and services, such as embroidery hoops and cotton gun patches used in analytical work. And a group of Texas oil well drilling experts was retained by the Victoria plant to perforate the steel casing in a 5,000-foot brine disposal well.

Watch the Du Pont "Show of the Month," CBS Network

Importance of credit cards pointed up by findings of new Du Pont survey

What do people really think about oil company credit cards? Finding the answer to that question was one of the objectives of a new study of service station customers' motivations recently completed by National Analysts, Inc., Philadelphia, for the Du Pont Petroleum Chemicals Division.

The survey revealed that 58% of the 2,036 motorists interviewed were favorably disposed toward the credit card principle. Only 16% were opposed, while 26% were undecided. Apparently *this* group is ripe for credit card promotion. An earlier Du Pont survey showed that credit card customers are more loyal to one brand of gasoline than those who do not buy on credit.

Here's why . . .

The new Du Pont survey probed also into the reasons why customers are predisposed toward credit cards. Card holders gave varying reasons for using them: for example, that they were convenient to have on trips and that they enabled motorists to buy gasoline when short of cash. A few card holders retained oil company invoices as records of gasoline and oil purchased.

In spite of the fact that the majority of service station customers' attitudes toward credit cards were favorable, only 18% of all motorists had cards. Of these, 13% had one and 5% had cards from more than one company.

Motivations vary by region

The national survey report has been analyzed to determine regional differences of habit and opinion.

These of course will prove of interest to all oil company marketing men, but especially to those with only regional distribution.

Credit cards are more widely accepted and used in the west coast and southern states.

Such information is but a small part of this new survey. The complete findings have been published in the new book, "Buying Patterns at Service Stations," now being distributed to oil company marketing executives. Requests from others in the industry will be welcomed and filled promptly.

SALES OFFICES

Chicago 3—8 So. Michigan Ave. . . . RAndolph 6-8630
Cleveland 15—25 Prospect Ave. . . . SUperior 1-1363
Denver 2—Petroleum Club Building, 16th & Broadway . . . . . AComa 2-2347
Houston 2—705 Bank of Commerce Bldg. . . . . CApitol 5-1151
Los Angeles 17—612 So. Flower St. MAdison 5-1691
New York 20—1270 Ave. of the Americas . . . . COlumbus 5-2342
Philadelphia 2—3 Penn Center Plaza LOcust 8-3531
Pittsburgh 22—1 Gateway Center . . ATlantic 1-2933
San Francisco 4—111 Sutter St. . . . EXbrook 2-6230
Seattle 3—4003 Aurora Ave. . . . . MElrose 6977
Tulsa 1—1811 So. Baltimore Ave. . . . . LUther 5-5578
In Canada—Du Pont Company of Canada (1956) Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**—Ontario . . . . . HUdson 1-6461
In Other Countries—Organic Chemicals Department, Export Division, 7447 Nemours Bldg., Wilmington 98, Del., OLympia 4-5121, Ext. 2962.

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Better Things for Better Living . . . *through Chemistry*

DU PONT TETRAETHYL LEAD AND OTHER PETROLEUM CHEMICALS

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

A-5449

Printed in U. S. A.

Suppliers . . .

Salle College, Philadelphia, where he majored in chemistry, and is a member of the American Chemical Society and the Philadelphia Rubber Group of which he is a former chairman.

His duties as director of purchases will include supervision of all purchases for Quaker Rubber Division including Quaker Rubber works in Philadelphia, Penna., and the Quaker Pioneer works in Pittsburg, Calif.

TRACERLAB, INC., has announced the appointment of **George T. O'Dea** as controller. He will be responsible for all cost, general accounting and budget functions, and will report directly to the president, **S. S. Auchincloss.** He has worked with Auchincloss during his affiliation with two AMF companies, the Leland Electric Co. of Dayton, Ohio, and the Cleveland Welding Co., the latter of which was headed by Tracerlab's president.

O'Dea served in the United States Army from 1942 to 1945, and received an Associate of Arts degree from University of Chicago in 1939 and a Commerce diploma from Northwestern University in 1952.

MINNEAPOLIS-HONEYWELL REGULATOR CO. has announced the appointment of **E. J. Byrne** as petroleum industry manager for the Industrial division, **J. A. Robinson,** field sales manager, announced recently.

Byrne joined Honeywell in 1947 as an industrial instruments salesman in the Houston office. He subsequently was industrial sales manager in the Dallas office and for the last four years served in the same capacity at Houston.

Robinson also announced that **K. R. Knoblauch,** who became associated with Honeywell in 1924, will devote full time to duties as chemical industry manager on a national basis. Knoblauch formerly was metals processing industry manager.

Two new industrial managers have been named for the Dallas and Houston offices. At Dallas, **Paul R. Sharadin** succeeds **Robert Harris,** who becomes district manager at Tulsa. **C. D. Walker** succeeds Byrne at Houston. Walker joined Honeywell in 1948, Sharadin in 1951.

Philip J. Wenz, manager of the Service and Repair division of De Laval Steam Turbine Co., Trenton, N. J., has died after an illness of several months. He was 63 years old and had joined De Laval in 1910.

VULCAN-CINCINNATI, INC., has announced that its general purchasing agent, **Elmer G. Kahle,** retired last month. No successor will be named to fill Kahle's position as each of Vulcan's three divisions will perform their own purchasing with the following being responsible: **R. M. Geist** for Vulcan Engineering division, **R. F. Witt** for Vulcan Manufacturing division, and **Robert Jeanmougin** for Vulcan Construction division.

Kahle joined the Vulcan organization as a draftsman in 1911 following his graduation from Ohio Mechanics Institute. He advanced to serve the firm's founder in many important executive positions, and as Vulcan grew, figured prominently among those who managed the company's advancement. For a number of years he was manager of the Estimating department, then he became general superinten-

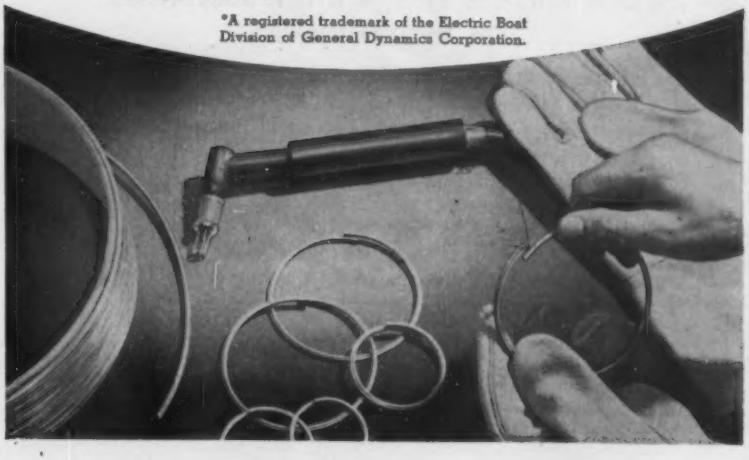
NEW PROCESS
assures improved pipe welds

announcing the ARCOS

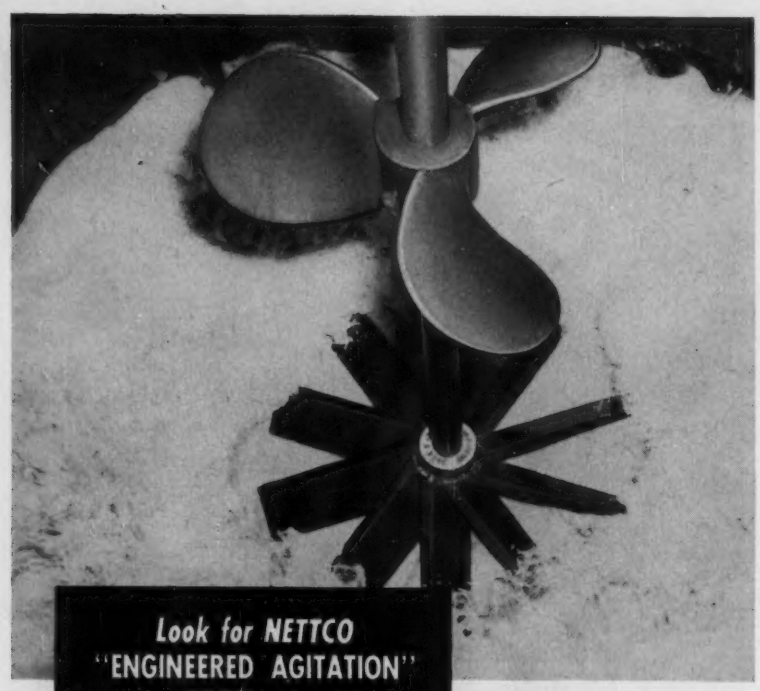
EB* WELD INSERT

To meet modern requirements for better pipe welds where high temperature, high pressure, and corrosive conditions exist, Arcos now offers the Consumable Weld Insert. Used for making the root pass, the EB Insert assures sound crevice free welds with smooth uniform inside contours. Saves money and time in fabrication . . . minimizes turbulence, and promotes trouble free service. Write for details. ARCOS CORPORATION, 1500 S. 50th St., Philadelphia 43, Pa.

*A registered trademark of the Electric Boat Division of General Dynamics Corporation.



For more data on advertised products, use Readers' Service Cards, last page.



Look for NETTCO
"ENGINEERED AGITATION"
in BOOTH No. 79
CHEMICAL SHOW
December 2-6, 1957
Coliseum • New York, N. Y.

Don't leave the Spinning of your Agitation Wheel to Chance...!

Whether you use a propeller, paddle, or turbine mixer to meet your process demands depends upon how well the fundamentals of agitation are applied to your particular problem. These agitation fundamentals were also basic in developing the most complete, best engineered agitator line available . . . that offered by NETTCO! Stop at our booth at the Chemical Show and see what ENGINEERED AGITATION can mean to you . . . dollar-wise, performance-wise, and NETTCO-wise!

Backed by over 50 years of experience...

- TANK TOP AGITATORS
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If you are unable to attend the show, send your process specifications directly to NETTCO agitation engineers for recommendations. Request free literature on any or all of the agitators listed above. Address requests to New England Tank & Tower Co., 81 Tileston Street, Everett 49, Massachusetts.

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Please send me the following literature:
☐ Tank Top Agitators—Bulletin 551
☐ Portable & Tripod Mixers—Spec. Sheets
☐ Pipeline-Flomix®—Bulletin 531
☐ Side Entering—Bulletin 532

Suppliers . . .

dent of Vulcan's shops. In 1946 he was made general purchasing agent for the entire organization, and shortly thereafter was elected to the board of directors.

Kahle's entire working career of 46 years was devoted to Vulcan except for one brief period in 1918 when he served in the U. S. Ordnance department during World War I.

TREOLITE Co. of California, division of Petrolite Corp., has added Wendell G. Markham as a research chemist. For the past eleven years Markham has been associated with B. J. Service, Inc., in the capacity of chief chemist working in the fields of oil well cementing, production, stimulation, and corrosion.

Markham received his B.S. degree from Colorado State and his M.S. degree from Oklahoma A. & M.

REFRACTORIES DIVISION of The Babcock & Wilcox Co. and the John J. Foster Mfg. Co., of Santa Ana, Calif., have reached an agreement through which the latter is granted exclusive selling rights of B&W insulating material, in the United States and Canada for use in aircraft manufactured in the two countries.

In making the announcement today, **Mark J. Terman,** sales manager of B&W's Refractories Division, explained that the agreement covers such applications as insulating blankets for tail pipes and afterburners of jet engines, and for firewalls in airframe structures.

CATALYSTS AND CHEMICALS, INC., a new firm, has been formed in Louisville, Ky., for the manufacture of specialty catalysts for the chemical, petroleum and food industries. Principals of the new company are **Dr. R. E. Reitmeier,** Louisville, **Dr. J. L. Parker,** Tulsa, and a group of technical associates.

The main offices, research laboratories and manufacturing facilities will be located in Louisville, where the firm has purchased a block of manufacturing buildings formerly occupied by the Mengel Company.

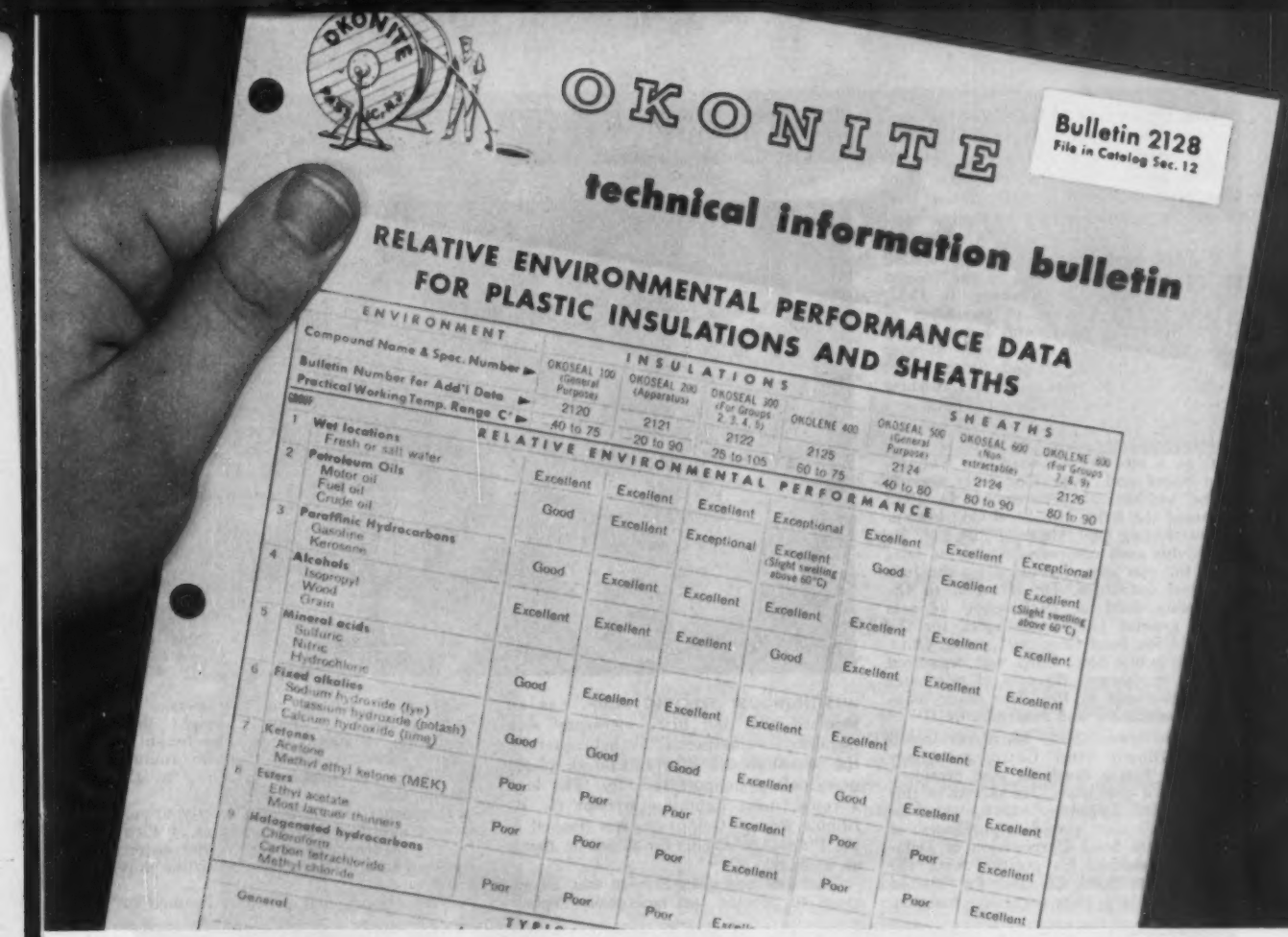
The company announced it will engage in the manufacture and development of specialty catalysts which are used primarily in the manufacture and purification of various industrial gases, synthetic fertilizers, organic chemicals and a variety of petrochemical products.

Reitmeier was formerly manager of the catalyst division of the Girdler Co. and has been active for a number of years in the field of industrial catalysts. The associated group of chemists and engineers includes **Earl Englert,** catalyst sales, **John S. Cromeans,** technical service, **Dr. Harold W. Fleming,** research and development, **Dr. Kenton Atwood,** staff technical consultant, and **Paul E. Huber,** catalyst manufacture.

UNITED STATES STEEL CORP. has appointed **Ralph C. Moffitt** vice president-purchases it was announced recently by **Harvey B. Jordan,** executive vice president-operations.

Moffitt will succeed **Carl A. Ilgenfritz** who retired October 1 after eleven years' service as head of purchasing for United States Steel.

Born in Fresno, California, Moffitt is a graduate of the University of California. He joined United States Steel in the pur-



How to pick the correct plastic cable for your specific need

Bulletins prepared by Okonite's Engineering Department will help you select the optimum plastic-insulated electrical cables for various applications in your plant. These bulletins, compiled especially for the refining, natural gas and petrochemical fields, describe the several available Okoseal (polyvinyl chloride) and Okolene (polyethylene) insulation and sheath compounds. They provide, in detail, the dimensions, applications and the resistance of each to such environmental conditions as salt water, petroleum oils, paraffinic hydrocarbons, alcohols, mineral acids, fixed alkalies, ketones, esters and halogenated hydrocarbons.

Using these bulletins, you can choose the most effective insulation and sheath material for each environment. Okonite can provide you with longer-lived, more reliable circuits for power, control, machine tool, lighting circuit, motor lead, switchboard, communication and cathodic protection. Check and send in this coupon for complete information on Okonite plastic wires and cables.

THE OKONITE COMPANY, Passaic, N. J.
Kindly send me the free bulletins checked below.

- ☐ **BULLETIN 2120**—Insulated Power and Control Cable—600 Volts (Okoseal 100)
- ☐ **BULLETIN 2121**—Machine Tool and Switchboard Wire—600 Volts (Okoseal 200)
- ☐ **BULLETIN 2122**—High Ambient Petroleum and Chemical Resistant Wire—600 Volts (Okoseal 300)
- ☐ **BULLETIN 2123**—Oil and Gas Resistant Wire—600 Volts (Okoseal-Nylon, Type OGR)
- ☐ **BULLETIN 2124**—Multi-Conductor Control Cable—600 Volts (Okoseal 100)
- ☐ **BULLETIN 2125**—Insulated Power and Control Cable—0-5000 Volts (Okolene 400)
- ☐ **BULLETIN 2126**—Multi-Conductor Control Cable—600 and 1000 Volts (Okolene 400)
- ☐ **BULLETIN 2127**—Cathodic Protection Cable (Okolene 400)
- ☐ **BULLETIN 2128**—Relative Environmental Performance Data for Plastic Insulations and Sheaths

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4419

where there's electrical power . . . there's **OKONITE CABLE**

chasing department of the Columbia Steel Co. in San Francisco in 1940. In 1943, he was transferred to Provo, Utah, as purchasing agent—Utah operations. Two years later he moved to Pittsburgh as purchasing representative for Columbia Steel Co.

In 1947, Moffitt was appointed assistant to vice president-purchases of the United States Steel Corp. of Delaware. In 1951, he was named director of purchases of U. S. Steel Company, and retained the same title following the merger of that company with the United States Steel Corp. in 1953. He was appointed assistant vice president and director of purchases of United States Steel in 1955.

Ilgenfritz began his business career in 1910 as a storekeeper with the Youngstown Sheet and Tube Co., later serving in the mechanical department. In 1913 he joined the Brier Hill Steel Co., becoming purchasing agent in 1918. In 1922 he formed his own company, acting as sales agent for raw materials used by the iron and steel industries. He returned to the purchasing field in 1925 when he was named general purchasing agent for the United Alloy Steel Corp. at Canton, Ohio. When Republic Steel Corp. was organized in 1930, he became director of purchases of Republic and in 1933 was made manager of purchases and raw materials.

In September, 1945, Ilgenfritz joined Carnegie-Illinois Steel Corp., subsidiary of United States Steel, as vice president in charge of purchases. He served in this position until December, 1946, when he was elected vice president-purchases of United States Steel Corporation of Delaware. He retained his position with the United States Steel Co. and the United States Steel Corp. after successive mergers.

Suppliers . . .

WESTINGHOUSE ELECTRIC CORP. has announced that the first emergency shipment to be transported by helicopter left the Westinghouse East Pittsburgh plant's new rooftop heliport recently. The load, a replacement lightning arrestor for the Illinois Power Company, was rushed to the Pittsburgh airport for shipment aboard an airliner.

The new helicopter service was inaugurated to provide fast emergency replacement parts service to customers. The "whirlybirds" can handle freight shipments up to 500 pounds. The freight is carried either between the two runners or in special hoppers attached to the plane's side.

Shipments can be made directly to customers within a 100-mile radius of Pittsburgh. In other cases, the 'copter carries the load to a local airport for airline shipment.

The heliport, first privately licensed in-

CRESCENT ARMORED MULTITUBE

for Underground Runs

gives lowest cost with permanence for Instrument and Control Tubing

This construction of CRESCENT ARMORED MULTITUBE* may be laid in a deep trench for long underground runs without any further protection other than that offered by its lead sheath, asphalted jute, two layers of heavy galvanized flat steel armor with an asphalt impregnated jute outer covering.

The economy of this method is obvious. Also the copper tubes are completely safe from mechanical injury, and the thick asphalted jute coverings protect the metal from moisture, corrosion, earth acids and alkalies. Under road crossings where very heavy traffic is encountered, it may be buried in concrete poured into the bottom of the trench or it may be pulled through conduit.

Up to 37—¼" O.D. copper tubes may be furnished in this and several other forms of CRESCENT ARMORED MULTITUBE*, one of which should best suit your installation requirements at substantial cost savings and resulting in a better protected job. Licensed under U. S. Patent 2,578,280. *Registered Trade Mark.

SEND FOR BULLETIN NO. 356-G WITH FURTHER INFORMATION ON OTHER USES OF CRESCENT ARMORED MULTITUBE

CRESCENT INSULATED WIRE & CABLE CO.

TRENTON 5, NEW JERSEY

CORROSION RESISTANT... NO PAINTING WITH ALCOA RIGID CONDUIT

If you have motors, controllers, switchgear and other electrical equipment in damp or corrosive locations, Alcoa® Aluminum Electrical Rigid Conduit can serve you better than any other material.

Because it resists corrosion, it never needs maintenance painting. It is nonsparking. It has Underwriters' Laboratories approval.

But there are other advantages, too ...

It weighs about one-third that of steel. It's easier to cut, bend, thread, install. Factory-applied internal lubrication makes wire pulling easier and quicker.

It is nonmagnetic. You get up to 20% less voltage drop. Conductors can be separated, regardless of load.

It's surprisingly economical, too. Large sizes of Alcoa Conduit cost less than steel. When all factors such as maintenance and installation are considered, aluminum conduit in all sizes is competitive with steel.

Alcoa Aluminum Rigid Conduit is available throughout the country from warehouse stocks. Fittings, too, are readily obtainable, together with suitable Alcoa thread cutting and joint compounds.

Get the complete story from your nearby Alcoa sales office. Or use the coupon below to obtain literature and a generous sample of this better conduit.

NEW! "ALCOA THEATRE"
EXCITING ADVENTURE
ALTERNATE MONDAY EVENINGS

Aluminum Company of America
2325-L Alcoa Building
Pittsburgh 19, Pa.

Please send literature on *Alcoa Aluminum Electrical Rigid Conduit* and a one-foot sample.

Name_____

Title_____

Company_____

Address_____

City and State_____

For more data on advertised products, use Readers' Service Cards, last page.

PETROLEUM REFINER Classified Ads

Petroleum Refiner Now Classified Rates

RATES: Regular Classified (undisplayed) set in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

* * * * * * * * * * * * * * * *

HELP WANTED

CHEMICAL ENGINEER

Excellent opportunity with a West Coast Independent Oil Company (San Joaquin Valley). Refinery Experience, Process Design and Operation essential. Must have Engineering Degree. Salary Commensurate with ability and experience. Reply outlining personal history, photograph and work background. Box 277-R, PETROLEUM REFINER, Houston, Texas.

TECHNICAL ANALYST-WRITER

Broad-range job of technical writing and editing, including brochures, press releases, technical papers, reports, and monthly summary of petroleum-refining developments for high-level outside circulation. Desire engineer or chemist with knowledge of petroleum-refining and petrochemicals fields, plus prior writing experience. For more particulars send name and address to:

Personnel Manager
ETHYL CORPORATION
1600 W. Eight Mile Road
Ferndale 20, Detroit, Michigan

CHEMICAL OR PROCESS ENGINEER

Minmum of B. S. in Chemical Engineering, Refinery Engineering or equivalent. Experience required as process engineer or general experience in Chemical Engineering Laboratory of large oil refinery. With major oil company in Tulsa. Liberal company benefits. Address all replies, giving age, education, resume of experience and salary expected to Employee Relations Department, P. O. Box 2039, Tulsa, Oklahoma. Replies will be kept confidential.

PROCESS ENGINEERS

McKee has permanent opportunities for Chemical Engineers experienced in process design for Petroleum and Chemical Plants.

Send detailed resume to
G. VICTOR HOPKINS

ARTHUR G. McKEE & Co.
2300 Chester Ave., Cleveland 1, Ohio

HELP WANTED

"Champlin Oil & Refining Co. in Enid, Oklahoma has an opening in its laboratory for an experienced refinery chemist. Applicants should furnish a brief personal history including education and professional experience. Address all inquiries to D. G. Perkins, Chief Chemical Engineer, Champlin Oil & Refining Co., Enid, Oklahoma."

If You Want

Fast

Results . . .

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Use

Petroleum

Refiner

Classified Ads

They don't cost,

they pay.

Suppliers . . .

stallation in the state, is located on the roof of the shipping building. A large circular mat (lower right in paragraph) has been installed to serve as a landing area.

PARKER-FALLIS INSULATION CO. has been named by Johns-Manville as its insulation contact unit in both the North Central and South Central portions of Texas. In its new capacity Parker-Fallis will handle contract installation of Johns-Manville insulating materials.

President of Parker-Fallis Insulation Co., Inc., is **E. H. Parker** who has been in the insulation business for many years. vice president of Parker-Fallis is **George R. Crowdus,** who has also been connected with the insulation industry for many years. The company's San Antonio office is managed by **J. T. Lusk.**

H. K. PORTER CO. has named **James P. Raugh** vice president and general manager of the Refractories Division, according to an announcement by **C. L. Holbert,** Porter's president. Raugh previously has been vice president of operations for General Refractories Co.

Raugh, a graduate of the Naval Academy at Annapolis, joined General in 1929 as a salesman, became general sales manager, general works manager and finally vice president-operations. In 1953 he became president of Fleming, Raugh, Inc., a Philadelphia construction firm and simultaneously vice president of Frank Samuel & Co., Inc., trading and manufacturing concern in that same city.

During the war, with the rank of Commander, he was commanding officer of the Navy Pre-Flight School in Chapel Hill, North Carolina.

Porter's Refractories Division was formed earlier this year by combining its Laclede-Christy and McLain Fire Brick Divisions and with recently acquired Mullite Refractories Co. Headquarters are in Pittsburgh.

UNITED STATES STEEL CORP. has announced the promotion of Basil L. Bristow to field representative at Pawhuska, Okla. The announcement was made by **Mark Barkhurst,** Mid-Continent area manager for U. S. Steel's Oil Well Supply division.

Bristow has served as a member of the staff of "Oilwell's" branch store at Pawhuska since 1955. A native Oklahoman, he attended the University of Oklahoma and joined "Oilwell" in 1953 at Ponca City.

THE CHICAGO PNEUMATIC TOOL CO., New York, and **Elliott Co.,** a division of the Carrier Corp., Springfield, Ohio, have completed negotiations for the manufacture and sale of Lagonda type tube cleaners, cutter heads, tube expanders and related equipment.

The agreement provides for the Consolidated Pneumatic Tool Co., Ltd., London, a wholly-owned subsidiary of the Chicago Pneumatic Tool Co., to manufacture to Elliott domestic specifications, and to provide complete sales and service facilities throughout the Sterling area. Initial supplies will be available immediately, and regular production of the full range of equipment will be ready by the first of the year.

—Photo courtesy Standard Oil Company (N.J.)

How preheat makes a "30-hour day"

When you add a Ljungstrom® Air Preheater, your on-stream stills can give 30 hours of normal production in every 24 hours. That's more than an extra week of production every month!

The reason is that Ljungstroms recover valuable BTUs that are normally dissipated up the stack. By putting this heat back to work, higher flame temperatures are generated, heat transfer rates increased. You can save one barrel of fuel in every five, stay on-stream months longer because slag is virtually eliminated.

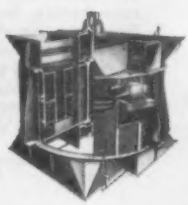
LJUNGSTROMS ARE WRITTEN OFF FAST

A Ljungstrom can pay out in nine months or less! The many other advantages show why: use of fuels you formerly threw away . . . more economical furnace design with no need for convection surfaces . . . minimum slag . . . shorter turn-around time . . . higher quality product (averaging 2 octane numbers higher than previously).

Detailed information is available. Learn about Ljungstrom's compactness, easy inspection, simplified cleaning. minimum maintenance, and the amazing economy and reliability story. Just call or write the Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.



The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

What's New in Equipment . . .

. . . and Manufacturers Literature

New Plastic Grid Improves Cooling Tower Performance

A new high impact plastic grid packing (Fluor Poly-Grid Packing) has been developed to meet industrial requirements for high performance and low pressure drop in cooling tower service. The packing is also applicable to other operations where efficient gas-liquid contact is desired, such as in gas scrubbing towers and trickling filters. The packing is made from high impact polystyrene or linear polyethylene and is available in a 3 ft. x 3 ft. grid. or 2 ft. x 4 ft. grid made of vertical ribs approximately two inches apart.

The polystyrene is resistant to water and most dilute aqueous solutions including non-oxidizing acids, salts and alkalies. It is therefore quite suitable for almost all cooling tower applications. Polystyrene is attacked by chromic acid, nitric acid, concentrated sulfuric acid, and by most non-polar organic solvents such as aromatics, chlorinated hydrocarbons, and ketones. For installations where greater chemical resistance is needed, especially where hydrocarbon compounds are present in the circulating liquid, the linear polyethylene is recommended.

Poly-Grid packing has been developed primarily for use in water cooling towers. However, it is well suited as a gas or vapor-liquid contact medium in many other applications because of its high mass transfer coefficient, low pressure drop characteristics and its relatively inert chemical structure. The open and non-clogging characteristics of the packing suggest its suitability also for use in scrubbing of solid particles from air streams.

Both packing materials are unaffected by biological growth and are resistant to deterioration in water and most aqueous solutions. With regard to performance coefficients and pressure drop, the packing is superior to most wood packings and is suitable in many instances for service which would normally use ceramics. The Fluor Corp., Ltd.

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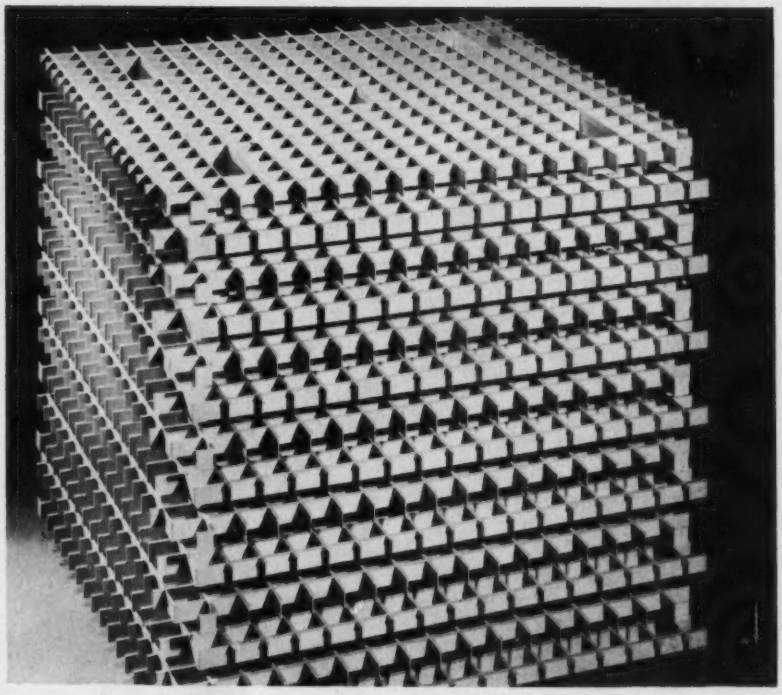
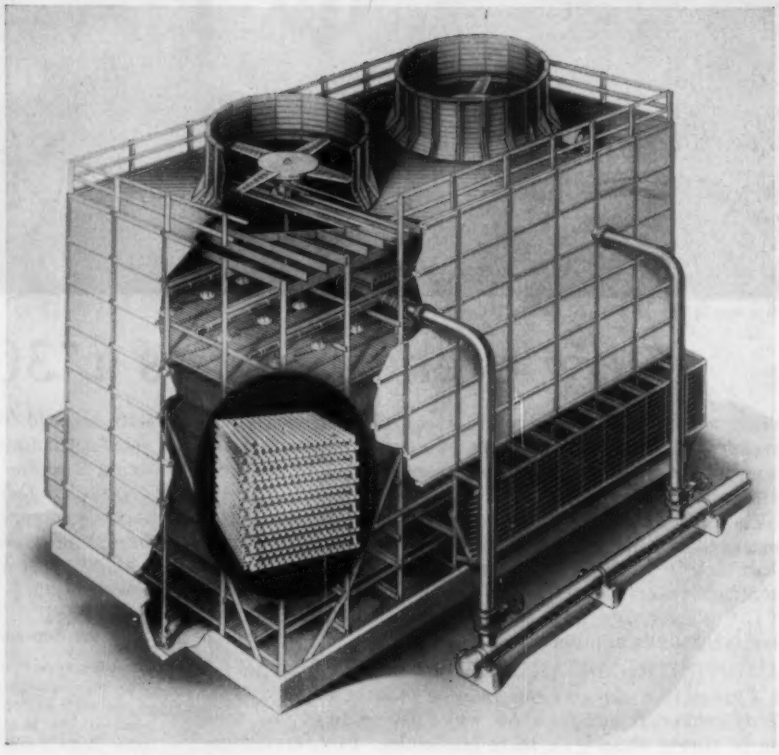




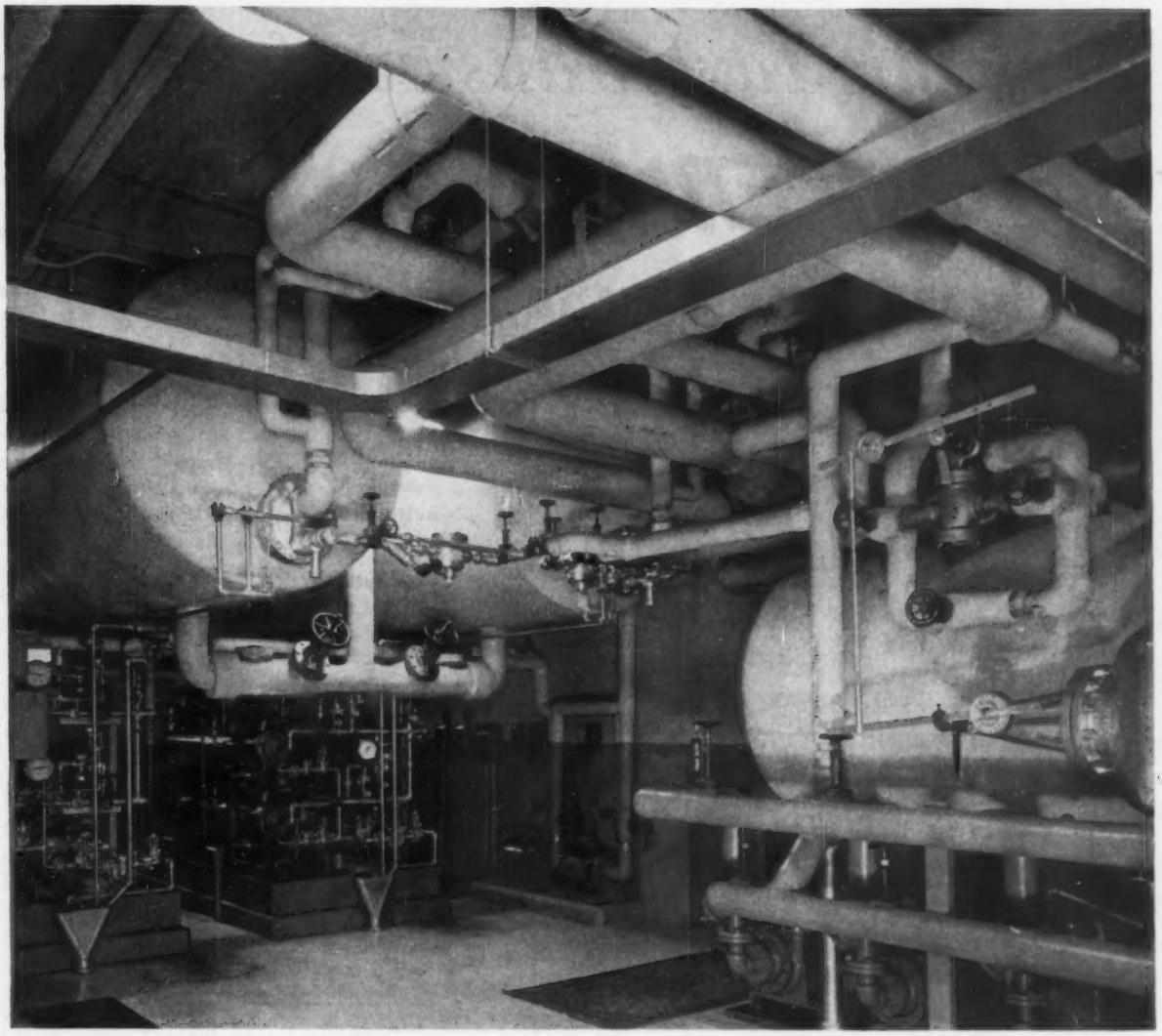
Quick Equivalents With Free Conversion Chart

The company is again offering, without obligation, its temperature conversion chart to engineers, students and others having use for this handy pocket size aid.

The easy-to-read tables of fahrenheit and centigrade temperature equivalents are an invaluable time saver to the busy man having frequent occasion to convert from one temperature to the other.

The tremendous response to the first offer several years ago and the favorable comments from those using the chart have prompted renewal of the offer.

The reverse side of the 8½-inch x 3½-



K&M HIGH-PRESSURE INSULATIONS WITHSTAND VIBRATION AND TEMPERATURE CHANGES!

Minimize Fuel Costs As Long As The Equipment Lasts!

You get more heat from every fuel dollar. With K&M High-Pressure Insulation, your fuel costs remain low . . . your process control more precise. Even severe operating conditions can't interfere with its insulation efficiency.

K&M High-Pressure Insulations meet every need. For temperatures up to 1900°F., use K&M Hy-Temp Combination—diatomaceous silica overlaid with K&M "Featherweight" 85% Magnesia. Staggered joints prevent heat loss through expansion-caused openings. For temperatures up to 1350°F., use K&M Kaytherm—hydrous calcium silicate bonded with asbestos fibers—important for power and petroleum applications. For temperatures up to 600°F., use K&M "Featherweight" 85% Magnesia—a basic carbonate of magnesia mixed with asbestos fibers. K&M High-Pressure Insulations come in a variety of sizes and thicknesses . . . in pipe and block insulation.

Write today to us for more information.

K·M
BEST IN ASBESTOS

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

For more data on advertised products, use Readers' Service Cards, last page.

Try this Taylor answer for tough

NO POCKETING...NO PURGING

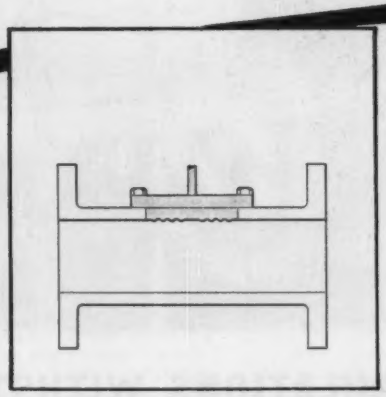
TYPICAL APPLICATIONS

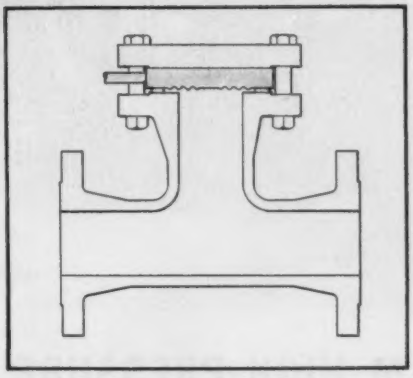
Flow Measurement of • Salt Slurries • Viscose • Liquid Sulphur • Sulphuric Acid • Caustic Solutions • Pulp Solution • HF Alkylation

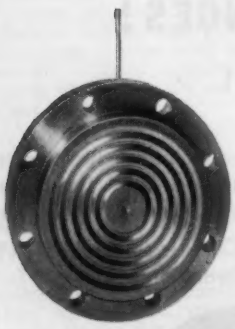
Taylor furnishes all required types of differential producing devices—including concentric, eccentric, segmental or quadrant orifice plates.

Level Measurement on • Caustic Evaporators • Emulsified Asphalt Storage Tanks • Batch Stills • Pharmaceutical Crystalizers

Differential Pressure Measurement • Fractionating Columns • Pumps • Filters







Type 95 flange (*left*), for use with chemical tee. For flow installations where diaphragm is flush with the inside of pipe, so that process fluid imparts a scouring action. Also for liquid level requiring flush installation. Maximum pressure 300 psi.

Wafer type sensing element (*right*), for use with standard 3″ ASA flange, where diaphragm need not be flush mounted, e.g., corrosive flow or liquid level measurement. Standard diaphragm material, for both types, 316 Stainless Steel; alternates available. Maximum pressure 1500 psi.

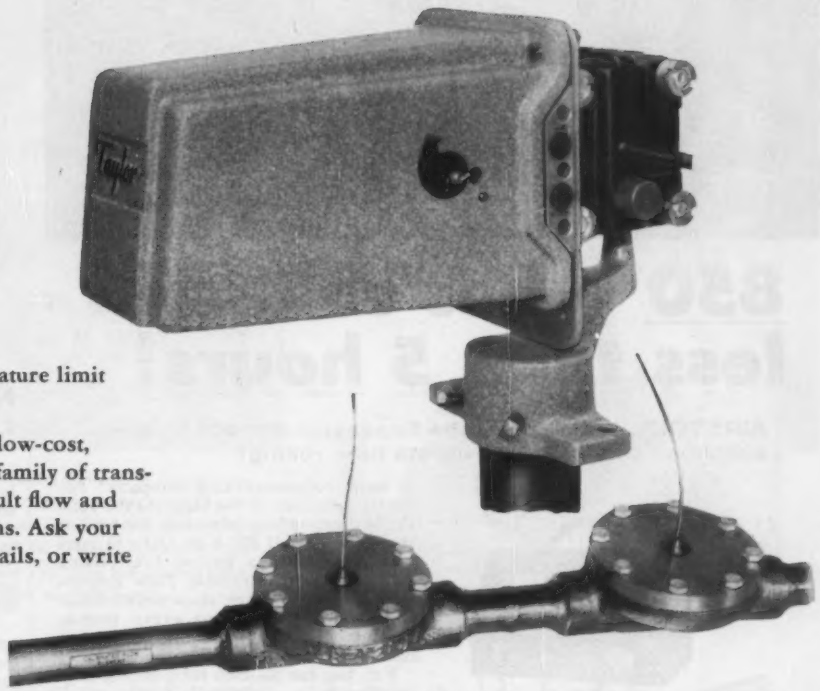
Taylor Instruments

Flow and Level measurement...

...NO PLUGGING... WITH THE NEW

205T VOLUMETRIC DIFFERENTIAL PRESSURE TRANSMITTER

Here at last is an economical way to eliminate purge and seal problems. The Taylor 205T Flow and Liquid Level Transmitter never has to be purged of deposited material and never suffers from corrosion, because it is completely isolated from the process material. The pressure-sensitive diaphragms may be installed flush with the inside of the pipe or tank in a variety of mountings. The temperature limit is 300°F. at the diaphragms.



Accurate, sturdy, dependable and low-cost, this latest addition to the Taylor family of transmitters can solve your most difficult flow and liquid level measurement problems. Ask your Taylor Field Engineer for full details, or write for **Bulletin 98281.**
Taylor Instrument Companies, Rochester, N.Y., or Toronto, Canada.

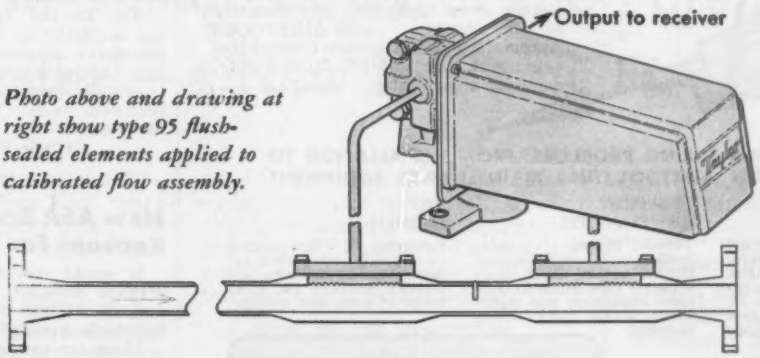
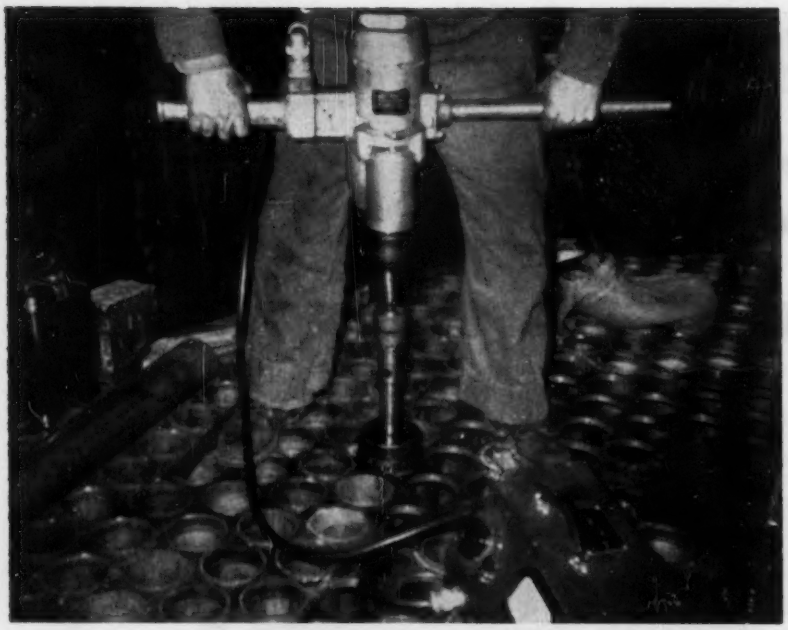


Photo above and drawing at right show type 95 flush-sealed elements applied to calibrated flow assembly.

VISION • INGENUITY • DEPENDABILITY

MEAN ACCURACY FIRST

For more data on advertised products, use Readers' Service Cards, last page.



850 tubes rolled in less than 5 hours!

AIRETOOL Automatic Tube Expansion Control System simplifies and speeds accurate tube rolling!

A large coppersmithing company* recently faced one of the biggest tube rolling and expanding jobs of its kind when they had to roll 850 4 in. OD x 13 gage copper tubes in a limited time. Using AIRETOOL'S Automatic Tube Expansion Control System, they rolled those tubes at a rate of one every twenty seconds . . . completed the job in *less than five hours!*

You too, can shorten tube rolling time immensely . . . eliminate costly over-rolling, over-expanding and distortion of tube sheets . . . with AIRETOOL'S Automatic Tube Expansion Control System. Ask for an ON-YOUR-JOB demonstration, today. *Name upon request

SOLVE ALL YOUR TUBING PROBLEMS, FROM INSTALLATION TO REMOVAL, WITH AIRETOOL TUBE MAINTENANCE EQUIPMENT

CONDENSER CLEANERS

Outside mounted . . . direct or gear driven. Powerful . . . fast . . . lightweight. Clean lightly scaled or completely plugged tubes to 1". Built-in flushing system cools drill, removes chips.

CONDENSER TUBE EXPANDERS

Parallel rolling . . . self-feeding . . . ball bearing thrust collar. Roll tight accurate tube joints to uniform expansion and tightness with maximum bonding.

TUBE CLEANERS

Powerful . . . fast cutting . . . quickly, completely remove hardest deposits. Air Driven motors in wide range of sizes and speeds.

Write for illustrated literature, (Bulletin 60), showing AIRETOOL'S complete line of tube maintenance equipment.

AIRETOOL

MANUFACTURING COMPANY

SPRINGFIELD, OHIO

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.
REPRESENTATIVES in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.

EUROPEAN PLANT: Vlaardingen, The Netherlands. CANADIAN PLANT: 37 Spalding Drive, Brantford, Ontario.

New Equipment . . .

inch chart illustrates by means of an animated demonstration, the easy reading qualities of thermometers made with the red glass reading column. This chart is easily carried in the pocket or wallet or may be placed under glass desk tops for easy reference. Moeller Instrument Co.

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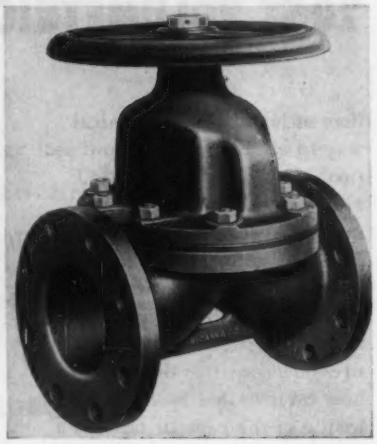


New Diaphram Valves Have Extremely High Strength

A new line of Ductile Iron Diaphragm Valves has just been announced. This line has been developed to meet an industry-wide requirement for a diaphragm valve with exceptional strength and resistance to fracture and thermal shock.

Valves cast of this material have the tensile strength of cast steel and approach the economy of cast iron as well.

The inherent toughness of ductile iron provides a diaphragm valve with high resistance to impact damage as well as thermal shock, satisfying the safety requirements of industry.

The Ductile Iron Diaphragm Valves are available as complete valves or replacement components of bodies, bonnets and handwheels and are available with screwed ends (½-inch - 3-inch) and flanged ends (½-inch - 8-inch). Hills-McCanna Co.

Circle E3 green card, last page

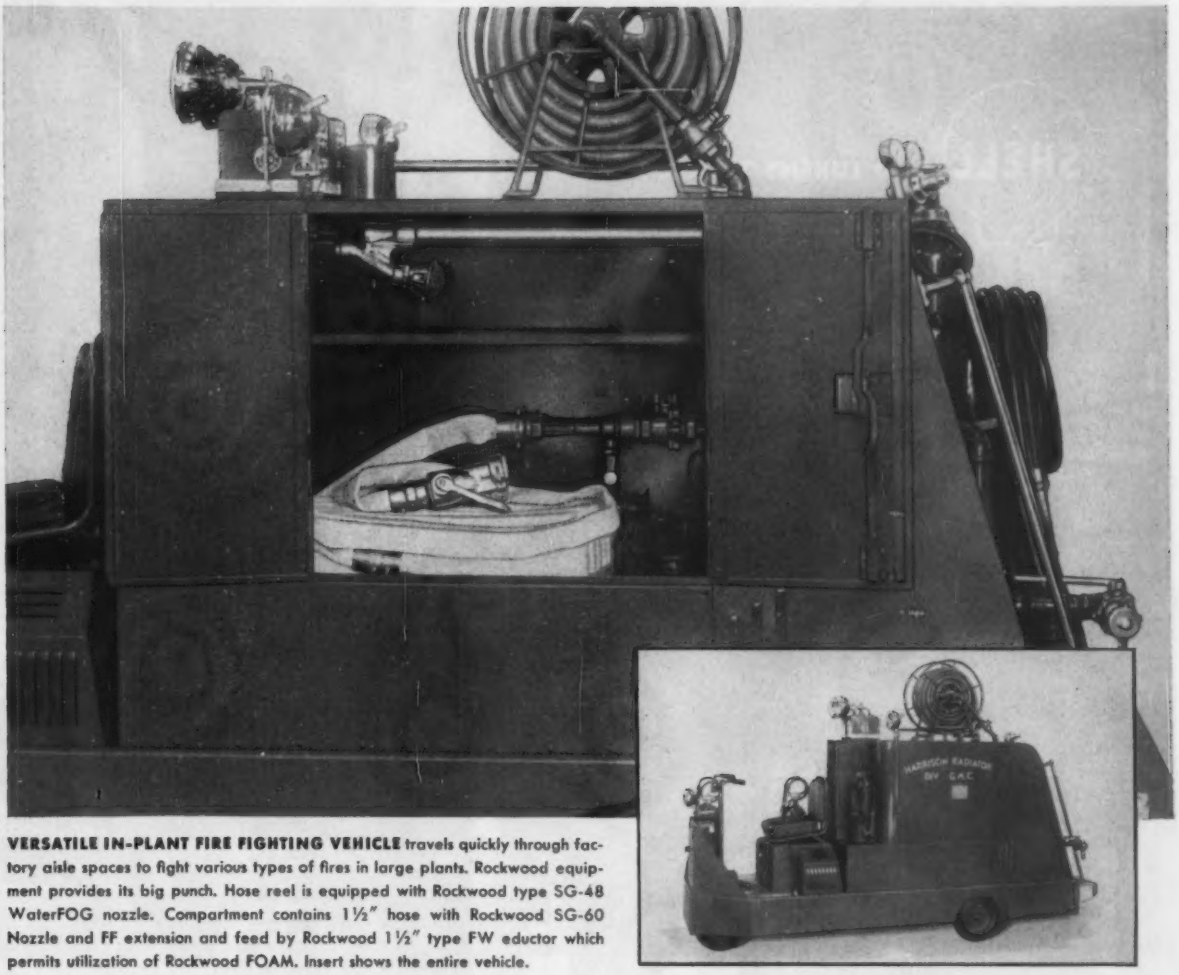
New ASA Brochure Gives Reasons For Standards

It would cost an individual company perhaps $500,000 to develop two standards that it can buy from the American Standards Association for $4.50.

These are two of the 1687 reasons why it pays American industry to invest more in American Standards, according to a new free brochure just published by ASA.

The brochure's title is "1687 Reasons Why You and Your Company Should Support the American Standards Association," and the 1687 reasons are the 1687 American Standards approved by ASA in almost every field of the American economy.

ASA is the national coordinating body and clearing house for voluntary engineering, industrial, and consumer standards.



VERSATILE IN-PLANT FIRE FIGHTING VEHICLE travels quickly through factory aisle spaces to fight various types of fires in large plants. Rockwood equipment provides its big punch. Hose reel is equipped with Rockwood type SG-48 WaterFOG nozzle. Compartment contains 1½" hose with Rockwood SG-60 Nozzle and FF extension and feed by Rockwood 1½" type FW eductor which permits utilization of Rockwood FOAM. Insert shows the entire vehicle.

The Inside Story of the Potent "Youngster"—a New In-Plant Fire Fighter

The Young Fire Equipment Corporation of Buffalo, New York, made this vehicle an even more potent fire fighter by installing Rockwood fire prevention equipment.

Here's How It Works

Rockwood FOAM is automatically proportioned (97 parts water to three parts FOAM) and introduced into the hose line by the Rockwood FW eductor. The Rockwood SG-60 WaterFOG nozzle fights fire five ways — by means of a solid water stream high-velocity WaterFOG, low-velocity WaterFOG from applicator, and from FF extension inserted in nozzle, a wide angle FogFOAM pattern and a solid FOAM stream.

Send For Full Information

Rockwood's wide variety of fire fighting equipment is engineered to quickly, safely control fires. Fill in the coupon below now.

Tested and listed by Underwriters' Laboratories, Inc. Distributors in all principal industrial areas.

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

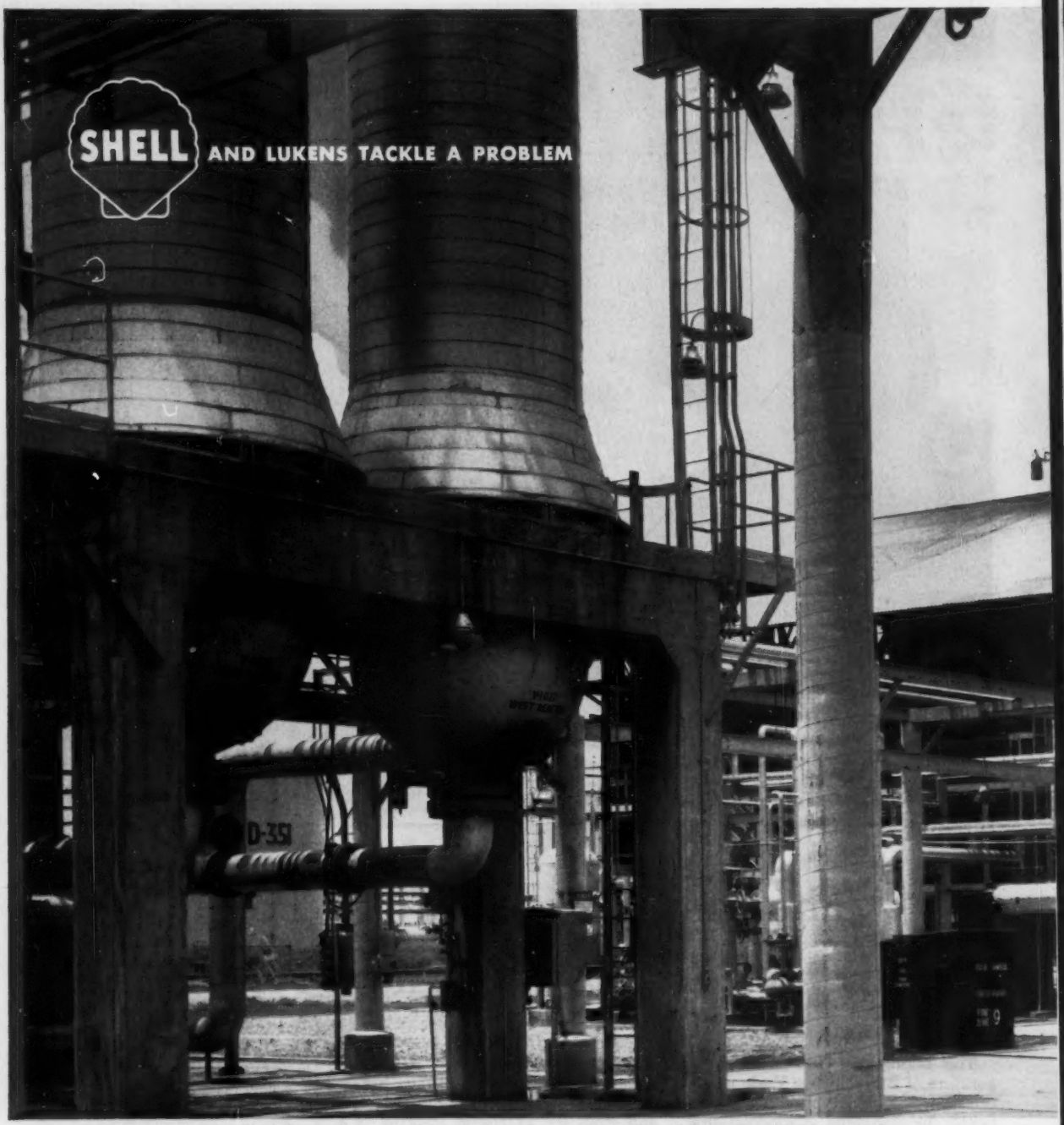
Distributors in all principal industrial areas

ROCKWOOD SPRINKLER COMPANY
Portable Fire Protection Division
2086 Harlow Street
Worcester 5, Mass.

Please send me your illustrated booklet on Rockwood fire fighting products.

Name .....
Title .....
Company .....
Street .....
City ..... *Zone* . . *State* .....

For more data on advertised products, use Readers' Service Cards, last page.



Two 78" diameter Shell Vapor-Phase Hydrodesulfurizer reactors fabricated with Lukens stainless-clad steel.

Teamwork pays off – designing desulfurizers and

Flued hemispherical heads answer need for uniform stress patterns

It took teamwork between Lukens and Shell . . . and at this modern Houston, Texas, refinery the results are rewarding.

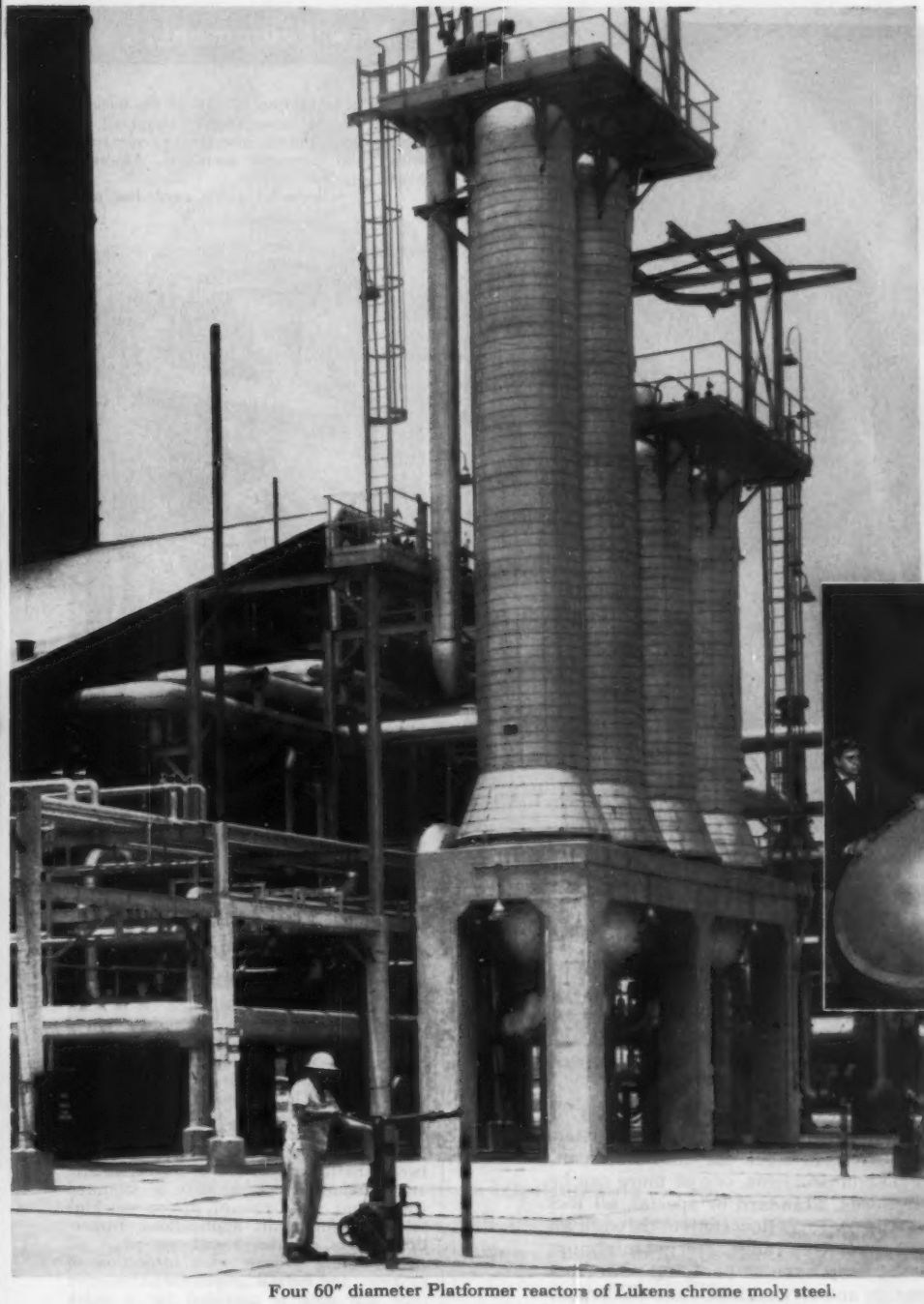
There were separate problems in selecting steels for the Shell V-P Hydrodesulfurizers and Platformers and a common problem of obtaining a more uniform stress pattern in heads of both.

In the 78" diameter V-P Hydrodesulfurizer reactors, Lukens stainless-clad steel with a backing of Lukens A-204 firebox steel provided the required high resistance to hydrogen and hydrogen sulfide attack at elevated temperatures, plus strength and protection against hydrogen embrittlement.

In the 60" diameter Platformer reactors, where design pressure is 800 psi and design temperature is 950 deg. F., Lukens chrome moly steel plate gave still greater strength-temperature handling ability, plus resistance to hydrogen attack.

And by the use of Lukens hemispherical spun and flued heads in both the V-P Hydrodesulfurizer and the Platformer, engineers and production men

For more data on advertised products, use Readers' Service Cards, last page.



Smooth contours and accurate location of the flued openings in these Lukens spun heads matched Shell's critical design needs.

Four 60" diameter Platformer reactors of Lukens chrome moly steel.

reformers with Lukens clad and alloy steels

achieved an outstanding advantage: Uniform stress patterns in the critical flued areas with added assurance of maintenance-free operation at high temperatures and pressures.

Ask your equipment builders about Lukens clad and alloy steels, or write for the new CLAD STEEL EQUIPMENT bulletin. Address Manager, Marketing Service, Room 969, Lukens Steel Company, Coatesville, Pa.

This is Lukens clad steel—not a lining, not a soldered-on surface, but a solid plate—one side corrosion resistant metal permanently bonded over-all to a rugged, economical backing steel.

LUKENS

Helping industry choose steels that fit the job

Photographer Bernard Hoffman found even the free flow of CO_2 from a cake of dry ice is difficult to control.

Controlling Flow in Fluid Engineering

To tame and control flow accurately, you must relate it to pressure, volume, turbulence and other variables. That's when you can look to the engineering leadership of S. Morgan Smith.

Butterfly valves are a good example. For the majority of processing situations, a wide range of standard R-S Butterfly Valves are assembled from stock for fast shipment. But for special fluid control problems, one or more can be applied to solve your needs. Standard or special, all R-S Butterfly Valves give you uniform flow control through all positions in the normal regulating range. You get minimum turbulence and pressure drop, save on pumping power because of simplified design and streamlined vanes. Compact and light in weight, they give you quick regulation and tight closure.

To learn more about the complete SMS line of Rotovalves, Ball and Butterfly Valves, call on our nearest representative. For information on special engineering, write S. Morgan Smith Co., York, Pa.

S. MORGAN SMITH HYDRODYNAMICS

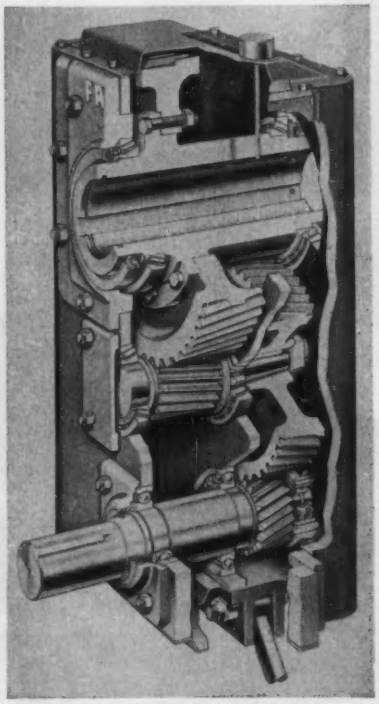
AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

New Equipment . . .

ASA is a federation of 116 of the nation's leading trade associations, technical societies, and public interest organizations, with 2300 company members. American Standards Association.

Circle E4 green card, last page



All Steel Shaft Drive Has Larger Capacity

Announcing the production of a completely new, larger capacity shaft mounted drive. The all steel shaft mounted drive is available in single reduction ratio of 5:1 and in two doubzle reduction ratios of 14:1 or 25:1. Unit ratings range from 2 hp at 5 rpm to 50 hp at 359 rpm; maximum torque rating at low speed shaft is 31,000 lb.-in. A longer center distance between shafts permits use of larger sheaves on installations where unit is mounted with input shaft toward driven machine or on through-shaft applications. Inspection covers on the 3-wall one-piece all steel housing provide easy inspection of bearings and helical gears. An automotive type dip stick is provided for a quick check of oil level. The Falk Corp.

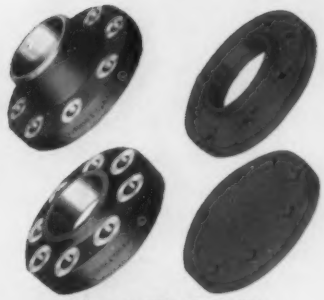
Circle E5 green card, last page

136 Page Valve Catalog Includes Technical Data

A new 136 page catalog covering the company's complete line of bronze and iron body valves has just been published.

The illustrated, hard cover catalog includes such recent additions to the line as the patented renewable seat ring bronze gate valves, composition disc bronze swing check valves and solder end globe valves with drain. An important modification of the 125 pound iron body gate valves—through-port design to reduce the tur-

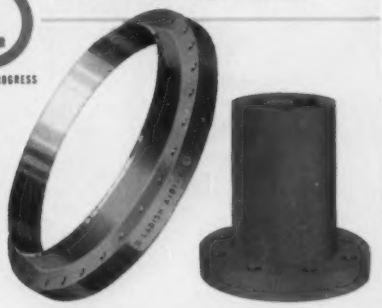
IPS—BUTT WELDING FITTINGS
½"-42" From Sch. 5S to 4" Walls



ASA and MSS FLANGES
½"-24" 150 through 2500 lbs.

TO MARK PROGRESS

TUBE O.D.—BUTT WELDING FITTINGS
½"-36" From .049" to .250" Wall



LARGE O.D. and TEMA FLANGES
Up to 20' in Diameter
LONG WELDING NECKS
1"-24" 150 through 2500 lbs.

UNIONS
⅛"-4" 150 lbs. and 2000 through 6000 lbs.

SCREWED and SOCKET FITTINGS
⅛"-4" 150 lbs. and 2000 through 6000 lbs.

LADISH

FOR *Complete Service* IN *Controlled Quality*

FORGED AND WROUGHT FITTINGS

CARBON • ALLOY
STAINLESS STEELS
AND ALUMINUM

WHATEVER your fittings requirements . . . regardless of the type, size, wall thickness, pressure rating or material specification . . . you can get prompt, efficient, *complete service* by specifying LADISH and ordering from your local Authorized Ladish Distributor.

A broad, full-range line produced to unsurpassed standards of metallurgical and manufacturing integrity . . . plus adequate distributor stocks . . . gives you double assurance of satisfaction.

For complete service on your fittings requirements . . . call your Authorized Ladish Distributor.

Catalogs available on request. Please indicate specific product lines for which information is desired.

THE COMPLETE *Controlled Quality* FITTINGS LINE

LADISH CO.

CUDAHY (Milwaukee Suburb) WISCONSIN

*District and *Regional Offices:* New York • *Baton Rouge • Buffalo • Pittsburgh • Philadelphia Cleveland • Chicago • St. Paul • St. Louis • Atlanta • Houston • *Odessa • Tulsa • Denver Los Angeles • *San Francisco • *Seattle • Havana • Mexico City • Brantford, Ont.

LOW DOWN . . . The low, sleek lines of the modern American automobile are made possible by an ingenious engineering achievement called the hypoid gear. It drives the rear wheels, but because it meshes *below* their centers, engineers are able to reduce an automobile's height. Lubricating the hypoid gear posed a tough, complex problem . . . a problem eventually solved by the combined research skill of the automobile and petroleum industries. Texaco scientists pioneered in developing a rugged petroleum lubricant for this special purpose . . . another evidence of the cooperation and resourcefulness that has made Texaco research a valuable partner of modern industry in its march of progress.

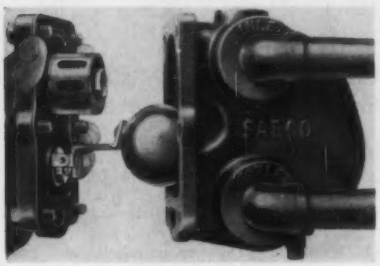
TEXACO ***progress . . . at your service***

THE TEXAS COMPANY

bulence and pressure drop in the flow through the valves—is illustrated in the sectional views of these valves.

Helpful technical data for the initial design of piping layouts are included in the "Useful Information" section of the new catalog. These data include a Table of Equivalent Resistance of Valves, Fittings, and Bends; and Charts for the Rational Solution of Pressure Drop for Liquids, Gases, and Steam. The use of these data permits rapid appraisal of the pipe sizes required for the particular flow requirements. The Fairbanks Co.

Circle E6 green card, last page



Easy Maintenance With Float-Thermostatic Trap

Improved, simplified, construction increases the accessibility of the company's float-thermostatic steam trap, type FT, greatly facilitating inspection, maintenance, and installation. The entire operating element of the new FT trap is one unit, which can be removed without disturbing inlet and outlet connection to the semi-steel trap body, suitable for 125 psi steam pressure. Operating elements consist of stainless steel valve mechanism, copper float, and bronze thermostatic air vent.

Valve is designed to provide condensate seal and prevent loss of steam. It discharges condensate at steam temperature continuously and without shock. Separate air vent, requiring no adjustment when pressure changes, removes all air and incondensable gases, allowing no steam to escape. Sarco Co., Inc.

Circle E7 green card, last page

Paper Tells Problems of Cooling Water Treatment

A technical paper entitled "A Case History in Cooling Water Treatment" has just been published.

The problems of corrosion and tower wood deterioration are commonly encountered in recirculation cooling water systems. At the Delhi natural gasoline plant in Louisiana the concurrent presence of these two problems resulted in plugging of heat exchanger tubes and in high metal loss throughout the system. The corrosive potential of the water was aggravated by "fiber throw" in the water caused by serious deterioration of the tower wood. The "fiber throw" enmeshed with corrosion products created cell action which produced serious pitting and tuberculation.

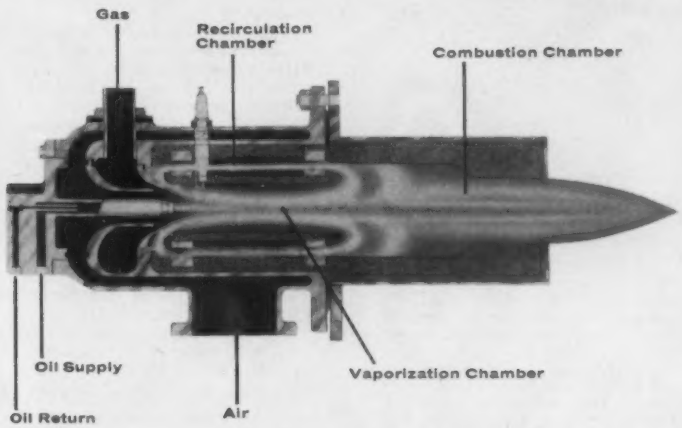
A program of treating the water was undertaken both to minimize the attack of the wood and to prevent corrosion. Effectiveness of the treating program was followed by corrosion studies to evaluate

THERMAL'S

COMBINATION

GAS-OIL BURNERS

the flame is the same . . .
with **OIL** *or* **GAS**



This versatile burner retains its high velocity combustion characteristics whether the fuel used is distillate oil or gas. The flame is short and non-luminous with an exit velocity of between 300 and 500 ft/sec. On either fuel, 85% of combustion takes place within the burner itself and the flame length seldom exceeds 1 ft. Switching fuels is simple and the burner need not be shut off during the changeover.

THERMAL combination burners provide high convection heat transfer for furnaces, dryers and air heaters and tempering air can be added without creating soot or smoke. Special applications include ladle heating, submerged combustion, skelp furnaces and packaged high capacity steam generators.

WRITE FOR BULLETIN #109

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Gas & Oil Burners • Heat Exchangers • Submerged Combustion • Air Heaters • Gas Generators • Combustion and Heat Transfer Engineering.

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Thermal Research & Engineering Corp.

CONSHOHOCKEN • PENNSYLVANIA

REPRESENTATIVES IN PRINCIPAL CITIES

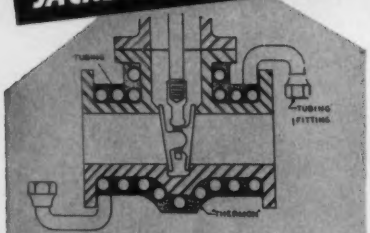
For more data on advertised products, use Readers' Service Cards, last page.

Thermon

The Revolutionary New Solid

HEAT TRANSFER MEDIUM

SAVINGS UP TO 75% over JACKETED EQUIPMENT



Typical Thermonized Valve Section

Thermon, the product, and Thermonizing, the process, represent a revolutionary new concept in the science of external heat application. Thermon is a non-metallic plastic compound with highly efficient heat transfer properties, and is easily applied in a viscous paste form over either steam traced or thermal electric systems. It completely surrounds the tracer tubing and conducts heat to the entire surface to be heated.

Definite Advantages of Thermonizing are:

1. LOW COST—save up to 75% over equal jacketed equipment.
2. EXCELLENT HEAT TRANSFER —Exceeds steam traced equipment approximately 1100% and very closely approaches jacketed equipment.
3. DEPENDABILITY—no hot or cold spots.
4. WIDE TEMPERATURE RANGE —used for sub-zero cooling or heating to 750°F.
5. NO JACKET PLUGGAGES OR PRODUCT CONTAMINATION —in case of equipment failure, Thermon separates product from heating medium.
6. GOOD MECHANICAL AND THERMAL SHOCK RESISTANCE —cracking, spalling, and degradation are all nil—less than 1% linear shrinkage.
7. ADAPTABLE—may be used with either steam traced or thermal electric equipment—installed at our shops or your job location.
8. RAPID DELIVERY—use of standard equipment permits minimum delivery time.

Write for comprehensive brochure about revolutionary Thermon!

THERMON MFG. CO.
1017 Rosine • P.O. Box 1961
Houston, Texas

New Equipment . . .

the benefits of each step taken. Initially, rather high treatment concentrations were necessary to keep corrosion under control. But as the clean-up program to aid in freeing the system of corrosion products and fiber took effect, the corrosion load was reduced, which permitted good control of corrosion with normal treatment concentrations. Betz Laboratories, Inc.

Circle E8 green card, last page

Silicone Insulated Wire for Greater Heat Resistance

Type RHH wires for general-purpose wiring, insulated with silicone rubber and having an asbestos braid, have just been announced.

These wires, available in the same range of sizes as standard butyl-insulated Type RHH wires—No. 14 Awg through 6 Awg —are the first to be listed by Underwriter's Laboratories for general-purpose wiring. Until now, listing for silicone-insulated wires has been limited to fixture and appliance wires.

Because silicone insulation has greater resistance to heat, these wires, consequently, have longer life. The added heat resistance makes them especially suited to power and lighting installations in factories, railroad shops and yards, and in commercial buildings with boiler rooms or other heat-problem areas.

Type RHH silicone-insulated wires are rated 600 volts, 90 C. operation. General Electric Co.

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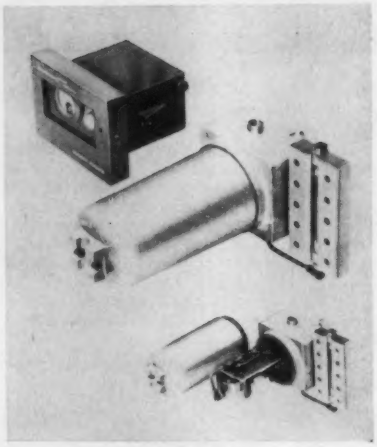
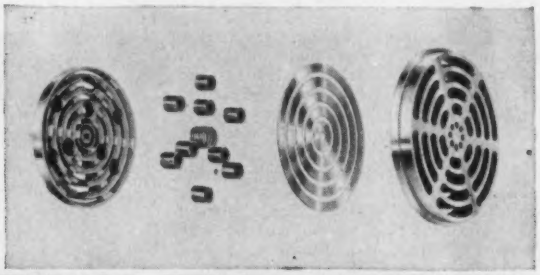


Check Moisture With Electrolytic Hygrometer

A new explosion-proof Electrolytic Hygrometer for industrial instrumentation in controlling corrosion, product purity and process efficiency, has just been announced. Analysis is performed by utilizing the principle of electrolizing all moisture in a gas stream by a special element. The current required for this electrolysis indicates the precise amount of moisture present in the stream. This unit automatically and continuously measures moisture concentrations in vapor samples with 5 percent accuracy in a 0-1000 ppm range at temperatures up to 100 C. Incorporated in the explosion-proof Hygrometer is a

VOSS VALVES in your machine mean



LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

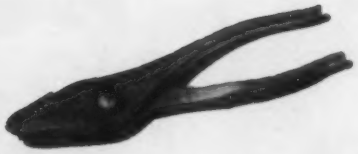
• up to 40% more valve area • minimum pressure loss • higher efficiency
• less power consumption • normal discharge temperature
• quiet, vibration-free • utmost safety • lower operating costs

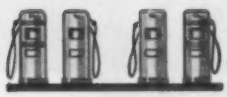
VOSS VALVES are made to specification, machined from solid stock (not cast) — VALVES and PLATES are of heat-treated alloy or stainless steel; PLATES are machined, not stamped, and ground for precise close-tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. SPRINGS, of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

J. H. H. VOSS VALVES REG. U.S. PAT. OFF.

J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.





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Tenamene

EASTMAN GASOLINE ADDITIVES

The formation of gums can play havoc with the performance you've so carefully built into your gasoline. Play havoc with sales, too. Let Tenamene gum inhibitors solve this problem for you—Eastman's highly qualified petroleum specialists will be glad to visit your refinery and recommend the proper additive for your needs.

For more information on Tenamene additives and the service that backs up their proper use, contact our local representative or write to EASTMAN CHEMICAL PRODUCTS, INC., *subsidiary of Eastman Kodak Company,* KINGSPORT, TENNESSEE.

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tennessee; New York City; Framingham, Mass.; Cincinnati; Cleveland; Chicago; St. Louis; Houston. **West Coast: Wilson Meyer Co.,** San Francisco; Los Angeles; Portland; Salt Lake City; Seattle.

For more data on advertised products, use Readers' Service Cards, last page.

SEE HOW SOUTHERN NITROGEN USED ALCOA ALUMINUM TO BAN CORROSION

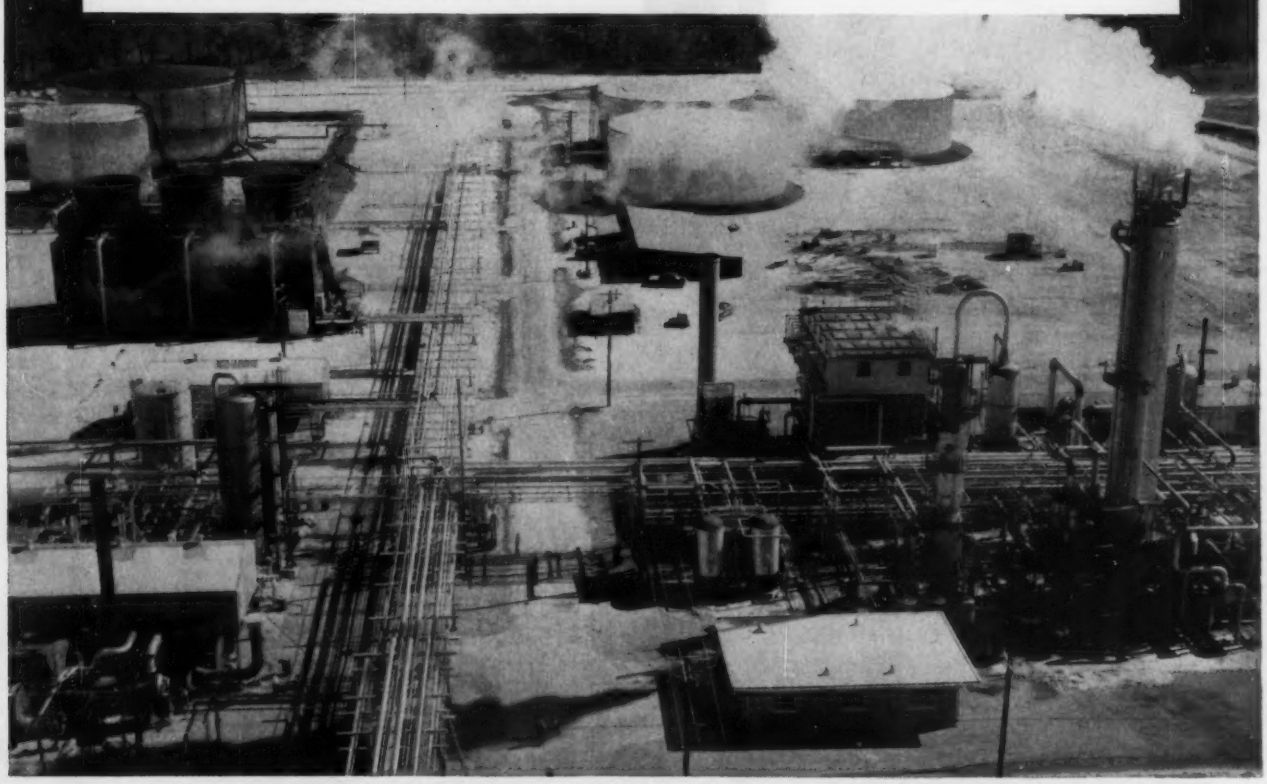
Southern Nitrogen Corporation, the South's newest nitrate fertilizer producer, recently completed a $14-million plant near Savannah, Georgia. Nearly everywhere you look in this modern processing operation you see ALCOA® Aluminum (over 500,000 lbs) at work to combat corrosion. The photographs on these pages show a few of the many ways it is used there.

It's easy to see why Southern Nitrogen used so much ALCOA Aluminum. No other metal provides so many valuable benefits for such a wide variety of uses. And ALCOA, alone, can offer unparalleled technical assistance based on over 30 years' experience applying *all these aluminum advantages in the process industries:*

- *Excellent corrosion resistance* extends service life and reduces maintenance to a minimum.
- *Light weight—high strength* make handling easy and economical . . . often permit substantial construction economies.
- *High thermal conductivity* combined with corrosion resistance often makes aluminum the lowest cost material suitable for many demanding heat transfer operations.
- *Nonsparking!* • *Nonmagnetic!* • *High reflectivity!*
- *Excellent electrical conductivity!*

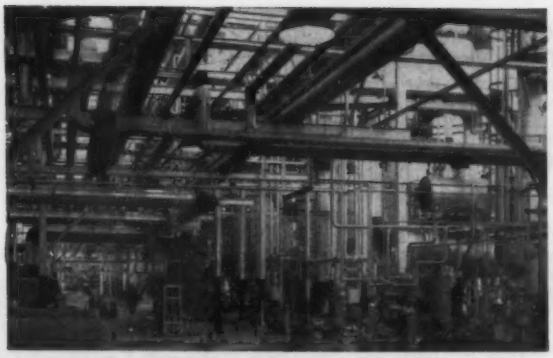
The plant designers, The Girdler Company, made full use of all the advantages of working with ALCOA. They were able to employ the unequaled aluminum experience of ALCOA engineers . . . to help them choose the right aluminum alloys and fabrication methods for dependable, corrosion-free service in every part of the plant.

When *you* have a metal problem, call on ALCOA to find a sound, economical aluminum answer. Consult the nearby ALCOA sales office listed in the Yellow Pages of your telephone directory. Or outline your metal needs in a letter to ALUMINUM COMPANY OF AMERICA, 905-L Alcoa Building, Pittsburgh 19, Pa.



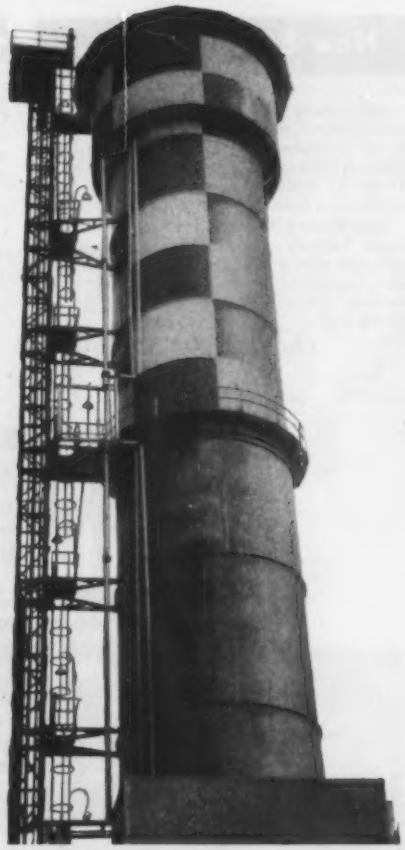
The Girdler Company designed this huge new nitrate fertilizer plant for Southern Nitrogen Corporation. The plant is designed for annual production of 120,450 tons of ammonium nitrate fertilizer, 91,250 tons of nitric acid, 10,950 tons of urea and 328,500 tons of fertilizer solutions.

For more data on advertised products, use Readers' Service Cards, last page.

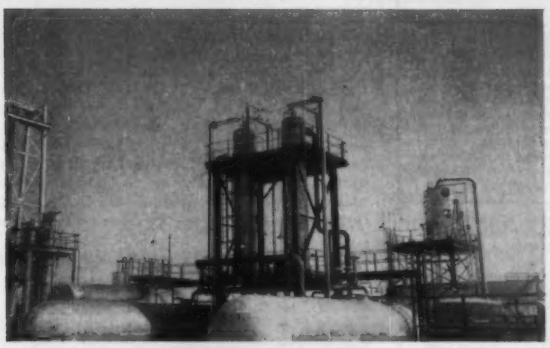


Plant employs thousands of feet of Alcoa Aluminum piping and conduit and is liberally painted with highly reflective aluminum coatings.

These 1,650,000 gallon storage tanks of Alcoa Aluminum alloy 5052 successfully fight the corrosive action of 85% ammonium nitrate. The tanks, 94 ft in diameter by 32 ft high, were built by Chicago Bridge & Iron Co.



Corrosion-resistant Alcoa Aluminum (alloy 6061-T6) was used throughout this prilling tower . . . to prolong service life without frequent, costly maintenance shutdowns. Built by The Steel Products Co., Inc., Savannah.



Alcoa Aluminum in these ammonia absorber coolers prevents corrosion while providing constantly high heat transfer efficiency. Coolers built by Henry Vogt Machine Co.

The superior corrosion resistance of Alcoa Aluminum in tank cars prolongs service life and prevents product contamination. Tanks built by Graver Tank & Mfg. Co., Inc. for Union Tank Car Co.

Lightweight gratings of Alcoa Aluminum are used in traffic areas throughout the Southern Nitrogen plant. They stand up under heavy traffic and easily withstand the attack of corrosive industrial atmospheres.

Alcoa Aluminum in electrical bus bar, conduit, fixtures and enclosures gives Southern Nitrogen effective protection from electrical breakdowns during prolonged exposure to corrosive industrial atmospheres.

NEW!
"ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

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New Equipment . . .

contact meter and relay for attaching an alarm system that can be set for any point in the instrument's range. A standard potentiometric recorder or recorder-controller 10 or 50 millivolt can be operated from the water vapor in a plant process stream.

The sensing element is thermostated to insure highest accuracy and is encased in an explosion-proofed housing that will meet requirements for Class I, Group D, Division I specifications. Beckman Instruments, Inc.

Circle E10 green card, last page

Bulletins Show How to Get Wet or Dry Film Thickness

Two new bulletins on paint film measuring instruments have just been released. One covers the company's Elcometer which is a magnetic type of dry film thickness gage measuring the paint film to an accuracy of plus or minus 0.0001 inches.

The second bulletin covers the wet film thickness gage which is valuable in determining the paint thickness when it is applied.

These bulletins furnish complete details on how these instruments work, their application, and a price list. Gardner Laboratory, Inc.

Circle E11 green card, last page

In Refractory Castables for the Refining Industry

WALSH has them ALL!

- Greater strength—better bond—throughout the complete temperature range.
- Maximum resistance to abrasion.
- "Iron-Free" (less than 1% iron content in Super Castable No. 32 & No. 50 NISF —to meet the needs of the petroleum refining industry.)

PRODUCT	MAXIMUM OPERATING TEMP.	WEIGHT DRY IN PLACE PER CU. FT.	FIRED CRUSHING STRENGTH (PSI)	
H & B Castable No. 8	2700° F.	128-130 lbs.	1100° F.—2000 1500° F.—1600 2000° F.—1900	WALSH H & B CASTABLES—Regular and Extra Strength—mix readily with water for casting, trowelling or air gunning. Form monolithic lining highly resistant to abrasion. Used for working linings in catalytic regenerators, reactors and other refinery equipment.
Extra Strength H & B Castable	2450° F.	128-130 lbs.	1100° F.—2200 1500° F.—1800 2000° F.—2100	
Castable No. 150	3400° F.	170-172 lbs.	1500° F.—7500 2550° F.—7600 3000° F.—8000	An hydraulic, "iron free" castable, producing highest resistance to abrasion at all temperatures.
Super Castable No. 32	3000° F.	130-134 lbs.	1500° F.—2900 2550° F.—3600 3000° F.—5000	Super Castable No. 32, an "iron free" castable, with excellent strengths at critical operating temperatures. Adheres readily where used as a patching material.
Lite Wate Castable No. 50	2100° F.	62-64 lbs.	600° F.—385 1500° F.—310 2000° F.—400	WALSH LITE WATE NO. 50 and 70, Insulating Castables. Can be readily trowelled and poured. Absolute minimum rebound loss when applied with air gun. Good strength with low heat conductivity—more than five times as resistant to heat flow than fire brick. Produce desired linings for flues and ducts, back-up linings for catalytic reactors and regenerators, and other refinery equipment.
Lite Wate Castable No. 70	2300° F.	80-82 lbs.	600° F.—500 1500° F.—450 2000° F.—1300	
Lite Wate Castable No. 50 NISF	2000° F.	51-53 lbs.	1000° F.—480 1500° F.—450	

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WALSH REFRACTORIES CORP.

101 Ferry Street • St. Louis 7, Missouri

For over 60 years manufacturers of high grade refractories

Low-Cost Level-Indicating Switch Is Versatile

A new level-indicating switch has been designed which may be incorporated by the customer into his own equipment. Known as the "Universal," this instrument is small, compact, low in cost and extremely accurate. Intended primarily for use in the oil sumps of machine tools, it is adaptable to practically any tank, vessel or container where a topping or low-level alarm or other level indicating device is desired. Depending on the requirements of the individual installation, the Model 1800 can be arranged to operate a remotely located warning light or other visual or audible alarm. By using suitable relays, it can also be arranged to start or stop pump motors automatically or to actuate automatic interlocking devices for the protection of equipment or operator. The Gems Co.

Circle E12 green card, last page

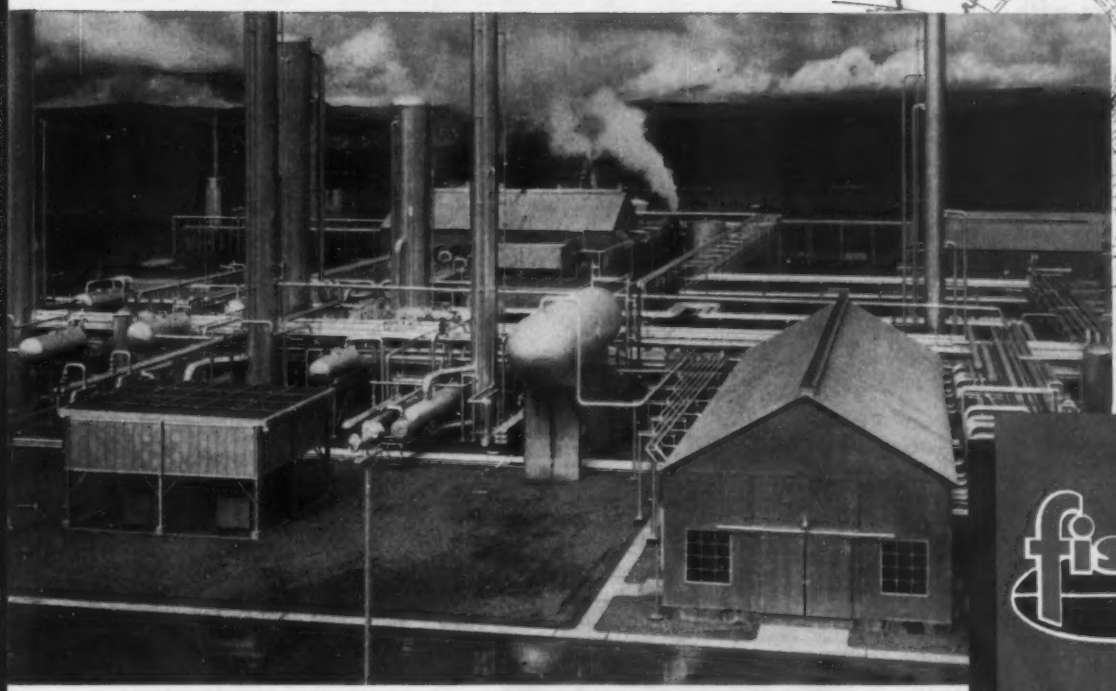
Condensate Return Unit Features Compactness

A new series of Condensation Return Units, in simplex and duplex units, in range of sizes from 500 to 150,000 EDR, 10 to 125 psi, and receivers 6 to 125 gallons—in speeds either 1750 or 3500 rpm, have now been designed.

The pumps are close-coupled end suction centrifugals, designed for low NPSH operation, suitable for condensate up to 212 F. Pump impellers are bronze, precision machined, and balanced. Low return inlets permit convenient connection to re-

This gasoline plant operates efficiently despite

varying loads



The San Juan gasoline plant of the Pacific Northwest Pipeline Corporation is big! It was designed to handle 300 million cubic feet of gas per day and recover 340,000 gallons of liquids. But efficient operation over a wide range of loads was necessary.

Since it was placed on stream in October, 1956, the San Juan plant has operated efficiently and dependably at loads ranging from 20 per cent to nearly 100 per cent of capacity. This is an unusual record for a plant of this size.

Furthermore, because of a rigid timetable imposed by pipeline commitments, the plant was constructed in record time despite many unusual problems posed by terrain, weather and transportation.

Because of transportation limitations, the 90-inch by 56-foot absorbers had to be shipped to the site in sections. There, welding assembly was completed in the field. The units were then inspected and stress-relieved.

This is just one example of the way the Fish Companies tackle problems. Your problem may be entirely different.

If you are planning new facilities in oil, gas or chemicals, call on Fish for imaginative engineering . . . from feasability study to final completion.

the fish companies

HOUSTON

FISH ENGINEERING CORPORATION
FISH NORTHWEST CONSTRUCTORS, INC.
FISH SERVICE CORPORATION

Prevent costly, dangerous connection leaks with

RECTORSEAL No. 5

Don't take chances with thread and gasket connections that leak—make them leakproof when you make them up by using Rectorseal No. 5. It does a perfect job on lines carrying gasoline, steam, weak acids, gas, propane, butane and many other products of the refinery and petro-chem plant.

Rectorseal No. 5 is slow drying—soft setting—non-hardening. Withstands pressures to 11,350 psi., temperatures to 350° F.

TRY IT NOW—WRITE FOR FREE SAMPLE and prove Rectorseal No. 5 seals better—goes further. Address Dept. "R".

RECTORSEAL DIVISION
RECTOR WELL EQUIPMENT CO., INC.
2215 Commerce Street • Houston 2, Texas

RECTORSEAL
THE POSITIVE LEAK PREVENTER

New Equipment . . .

turn lines close to the floor. Three pump discharge positions and two inlet positions promote flexibility of the unit. Vents are oversize. Receiver of cast iron. Float switch of approved type. Because pump is vertical, both compactness for saving floor space and quiet operation are achieved. Mechanical seals are standard. When stuffing boxes are desired they are cast integral with brackets and are of ample depth to prevent leakage. Pump may be removed from service without disturbing piping. Aurora Pump Division, The New York Air Brake Co.

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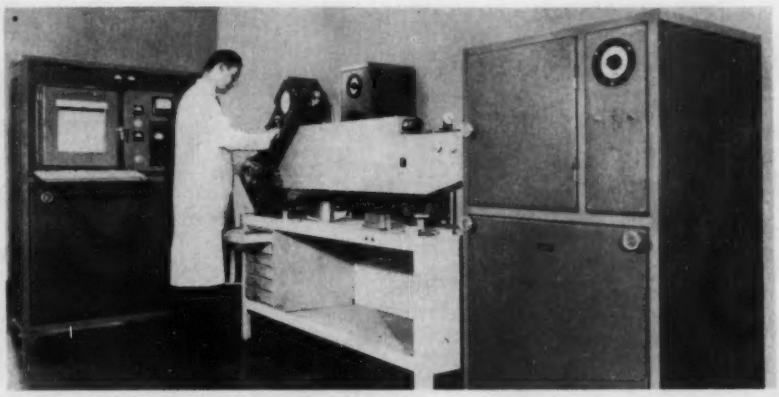
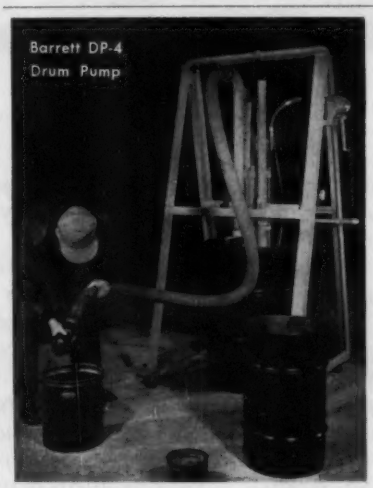


Metallurgical Analysis Made With Direct Reading

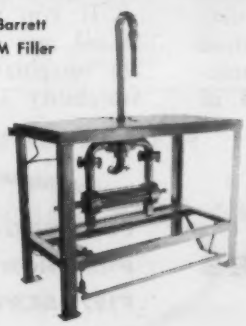
Direct reading spectrographic analysers manufactured in the U. S. A. use the so-called "integration" method. Now introduced in this country is the Automatic Spectro-Lecteur, the first direct reader which permits measurement of instantaneous values, and, therefore, direct and instantaneous reading of analysis results without resorting to integration. In direct reading spectrochemical analysis, the measurement is achieved by means of photomultipliers. However, the photomultipliers are used differently in the "integration" method and in the "Spectro-Lecteur" system.

Spectrochemical analysis is based on the intensity ratio of two spectrum lines: one



Barrett Crimping Head

Barrett
LM Filler



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filling, crimping and drum pumping machinery

for greases and other viscous products

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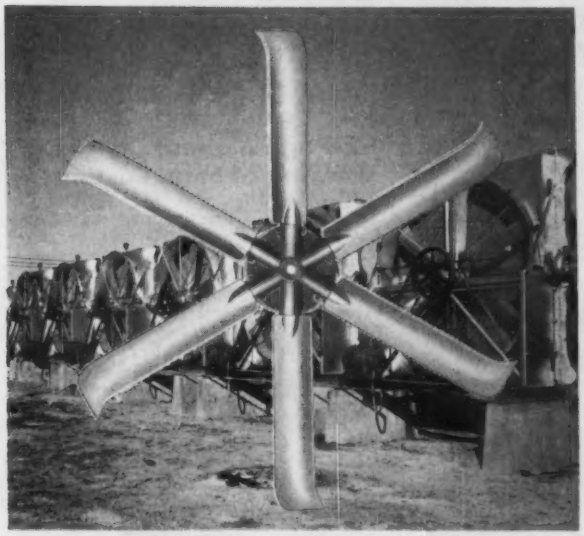
P. O. Box 8096 Houston 4, Texas

new adjustable pitch

"macheta" airfoil

Aerovent

54"–96" propellers



now available in

'T-ALLOY'

Acclaimed as *industry's most efficient air-moving* surface, Aerovent "Macheta" Airfoil Propellers are leading the way in cooling tower and heat exchanger fan design and engineering.

Latest innovation is the use of "T-ALLOY" for extra strength and additional corrosion resistance in especially rugged applications. Inherently a high-strength alloy, "T" provides better resistance to shock and vibration. This, plus *individual blade balancing* for complete interchangeability of all units and *universal pitch markings* to simplify accurate field setting, is your assurance of dependable, lasting performance in any installation.

STANDARD CONSTRUCTION ALUMINUM-ALLOY BLADES FURNISHED FOR ALL NORMAL-DUTY REQUIREMENTS

CAST ALUMINUM HUBS for light weight and ease of handling feature bolted construction for fast, easy assembly.

"POSITIVE-LOCKING" Pitch Adjustment is accomplished by keyways which hold peripheral-keyed blade shanks.

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LARGE PROPELLER DIVISION
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TULSA 3, OKLA.
Main Office and Factory
PIQUA, OHIO

NOISE and PULSATION Can Be Stopped Scientifically!

NOISES from intake and discharge piping of air, steam and gas systems

and

PULSATION and VIBRATION caused by surge in compressor, blower and pressure reduction systems

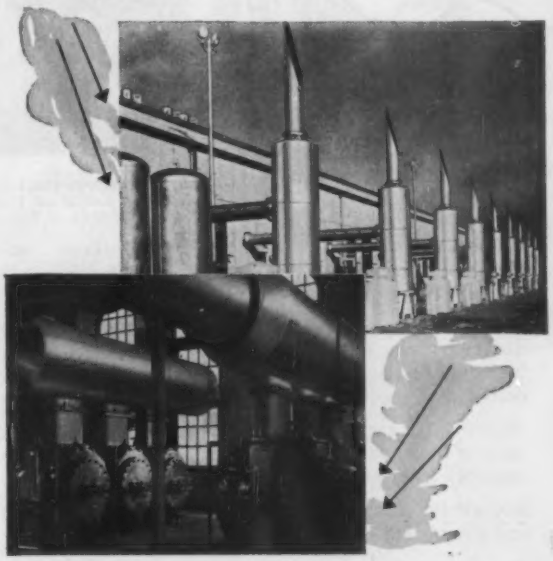
are effectively eliminated by
BURGESS-MANNING SNUBBERS

First, the B/M Snubbing Principle is scientifically correct and thoroughly proved in every branch of industry, and

Secondly, every Burgess-Manning Snubber is engineered to the specific application.

Burgess-Manning Snubbers attack noise and pulsation at the source. The pulse and slug of engine or compressor discharge is dissipated before it can be transmitted to atmosphere or other parts of the system. Elimination of the noise and pulsation problem will be money in your pocket through better equipment efficiency, improved production, reduced maintenance, elimination of operating hazards that result in costly errors, and improved neighbor and labor relations.

We invite you to present your problems for recommendations.

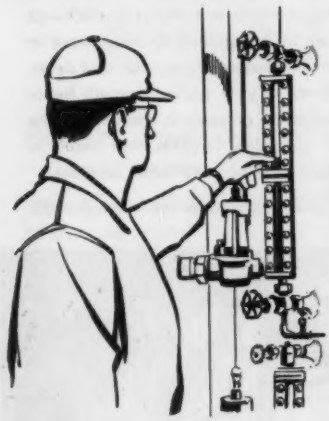


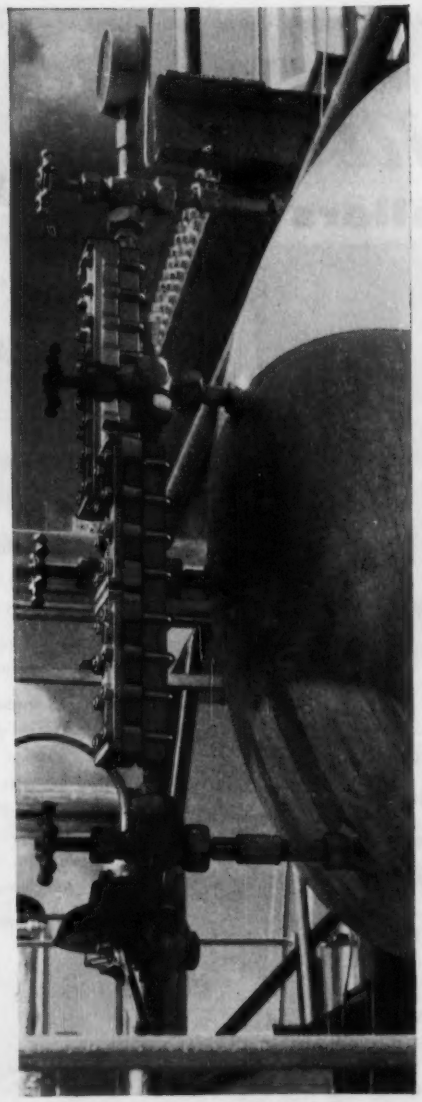
Write for free copies of case histories of representative installations and see proof of results.

BURGESS-MANNING COMPANY
Sound Engineering
11 East Park Avenue, Libertyville, Illinois
Dallas, Texas

For more data on advertised products, use Readers' Service Cards, last page.

It's easy to see why... Penberthy gages are preferred





● **PENBERTHY GAGES** on surge tank to gas treating plant of gas booster station. Natural Gas Pipeline Co., of America, Roberts County, Texas.

To be sure of clear, accurate liquid level readings... at temperatures from sub-zero to over 1000° F. and to pressures exceeding 10,000 psi... simply specify Penberthy Gage Sets.

Used extensively for fluids ranging from water to highly corrosive and dangerous chemicals, Penberthy gages are available in a variety of materials including bronze, iron, carbon steel, stainless, monel, etc. ... from stock or designed to specifications.

Exclusive construction features simplify maintenance, assure perfect alignment of frame with glass and gasket and permit servicing without removing assembly from vessel.

Request on your letterhead will bring you a copy of Catalog 36 detailing and illustrating complete line.

Everywhere... you're seeing more **PRODUCTS BY**

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Division of Buffalo-Eclipse Corporation
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PENBERTHY

- **EJECTORS**
- **INJECTORS**
- **CYCLING JET PUMPS**
- **LIQUID LEVEL GAGES**
- **GAGE VALVES**
- **SUMP PUMPS**

New Equipment...

line belonging to the spectrum of the basic metal in the alloy; the other, to the spectrum of one element contained in the alloy.

In the photographic-analysis method, the value of the ratio is obtained through measurement of the density of the plate. In the direct-reading method, this value is obtained through electrical measurement of potentials across the terminals of condensers loaded by the photomultipliers. Intercontinental Electronics Corp.

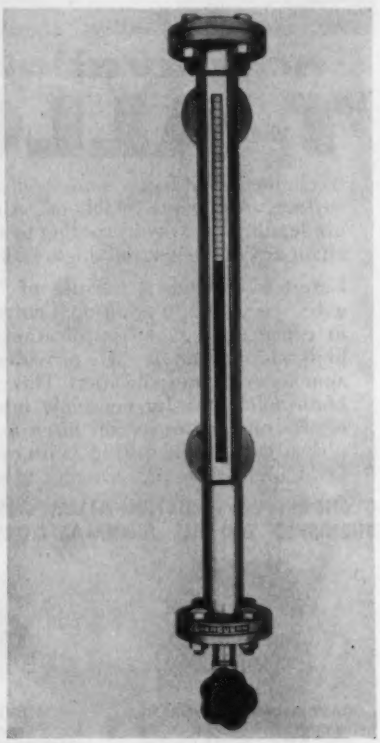
Circle E14 green card, last page

52-Page Manual Covers Welding of Steel Castings

Now available is the 1957 edition of "Recommended Practice for Repair Welding and Fabrication Welding of Steel Castings."

This 52-page handy reference manual is the result of a research project conducted by Battelle Memorial Institute under the sponsorship and general direction of the Steel Foundry Research Foundation. It represents the first revision of this manual since 1951 and contains a considerable amount of newly included material. Tempil Corp.

Circle E15 green card, last page



See Inflammable Liquids With Magnetic Gage

A new Magnetic Gage for the observation of liquid levels, especially designed for use where ordinary gages with glass, gaskets and threads cannot be tolerated due to dangerous inflammable or explosive conditions, has just been announced.

Safety against the slightest escape of

Ohio

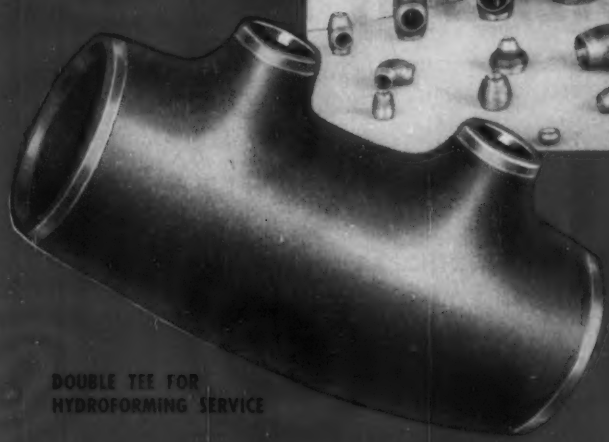
CAST ALLOY STEEL PIPENDS

EXTRA HEAVY BACK WALLS

100% MAGNAFLUX

18 X 14 REDUCING LATERAL FOR STEAM SERVICE 2005 LBS. AT 1000° F.

STANDARD BUTT WELDING FITTINGS TO ASA B-16.9



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single responsibility

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PRESSURE CONTROLS

FOR SPECIAL APPLICATIONS

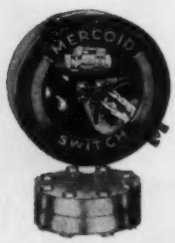
Low Operating Pressure—High Over-Range Protection

• EXAMPLE APPLICATIONS

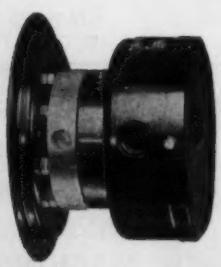
1. Provide low suction protection on pumps where suction pressure may go to very high line pressures (up to 2,500 psi.)

2. As an interlock to prevent a door to a pressure chamber from being opened until the pressure has dropped to atmospheric pressure (1" H_2O) with over-range protection to 600 psi.

• TWO SERIES AVAILABLE



Series DA-900: Bourdon tube operated. Over-range protection to 2,500 psi. Operating ranges 0-60 psi; 0-100 psi; 0-150 psi; 0-300 psi.



Series CP: Diaphragm operated. Over-range protection to 600 psi. Operating ranges 1"-60" pressure or 1"-60" vacuum.

Both types available in various style cases.

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dangerous gases is assured by the design which incorporates the gaging mechanism in a stainless steel chamber, mounts the special scale outside the chamber, and accurately indicates the level by magnetically actuating the scale through the chamber wall.

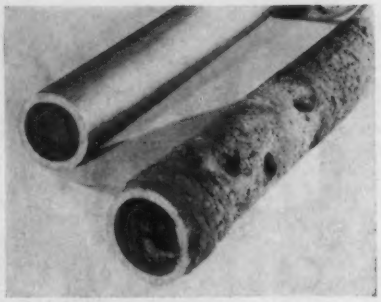
The scale consists of a series of edge-magnetized wafers which are attracted to each other to give a continuous scale. One side of the wafers is finished in bright red, the other side in silver. Changes in liquid level operate a special float which in turn magnetically turns over the wafers; thus the liquid level is accurately shown on the scale in a continuous red band contrasted with silver above. Jerguson Gage & Valve Co.

Circle E16 green card, last page

Results of Heat Treatment Studies Told In Bulletin

Engineers and buyers involved in the design and procurement of superior strength materials will be interested in the technical data offered in a new bulletin. This publication furnishes detailed information on the result of a study of the heat treatment of Croloy two-and-one-fourth (Grades T22 and P22). It details the yield strength, tensile strength, elongation, reduction of area and Brinell hardness at various annealing temperatures. The Tubular Products Division of The Babcock & Wilcox Co.

Circle E17 green card, last page

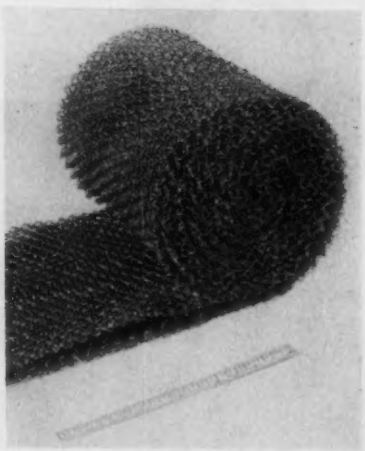


Nickel Alloy Coating Increases Heater Tube Life

An amazing increase in service life for tubing and pipe subjected to highly corrosive agents in piping systems and heat transfer equipment is available in the form of "Niphos" nickel alloy coatings. After application, the coating is fused by heating in a reducing atmosphere, into a protective nickel alloy cladding. The coating, or cladding, actually forms an interface with the base metal, adhering to it so tenaciously that no evidence of flaking, peeling or exfoliation is encountered, even after 180-degree bends, so often required in return-bend heat exchanger tubing, are formed of the treated units. The photo shows two identical one and one-half inch pipes, one clad and the other untreated, after being subjected to identical periods of service and corrosive atmosphere as part of tanker's heating coil system.

Since the Niphos coating also provides effective heat resistance to temperatures as high as 1150 degrees F., it prevents scaling of the base metal, an important

GOODLOE TOWER PACKING



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LOW H.E.T.P.

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Bulletin and additional information on request

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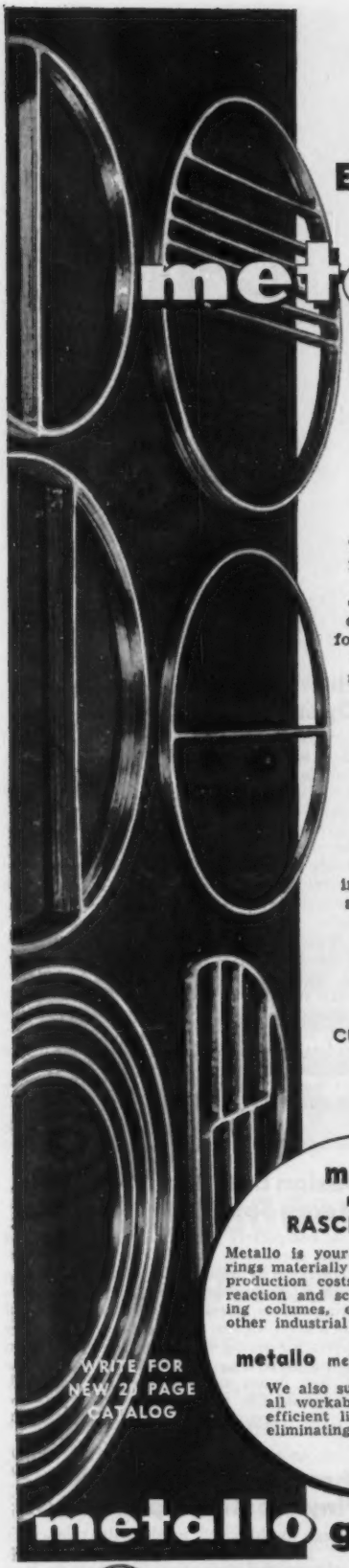
A Column Packing For Every Application



special gaskets for HEAT EXCHANGERS by

metallo

Fabricated in special shapes to exact specifications. Under fatigue of severe operating conditions, they are superior in sealing efficiency, longevity and ability to retain physical and chemical properties. These gaskets are built for specific purposes in strict accordance with customers' requirements or templates. When used for recommended services, they completely satisfy and give extra long life. A group of specially constructed Metallo Gaskets are made for heat exchangers with metal jackets and asbestos filler. These gaskets, including irregular shaped gaskets for any process equipment, are readily made in several different styles and shapes, in any metal and in sizes limited only by transportation facilities. These gaskets are also cut from solid sheet metal.

CUSTOM GASKETS GIVEN IMMEDIATE ATTENTION

Samples on Request

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metallic
RASCHIG RINGS

Metallo is your primary source. These rings materially decrease operating and production costs on a wide variety of reaction and scrubbing towers, rectifying columes, extraction systems and other industrial processes.

metallo metallic **LESSIG RINGS**

We also supply Lessig rings in all workable metals to act as efficient liquid distributors by eliminating cross flows.

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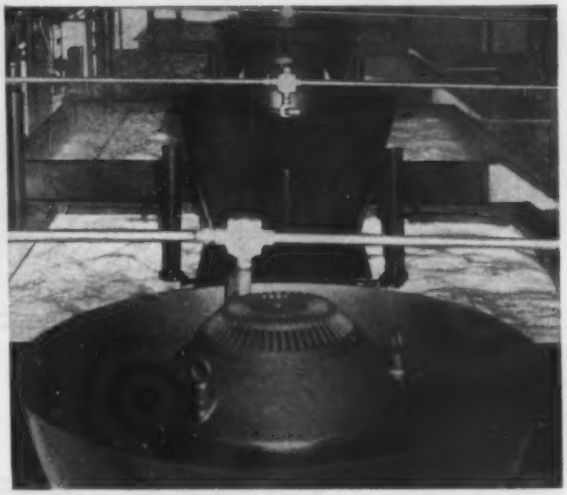
metallo gasket co.

15 BETHANY ST. • NEW BRUNSWICK, N. J.
Heat Exchangers, Raschig Rings, Lessig Rings, Gaskets, Valve Discs and Metal Stampings

HENDRICK HYDRO-DEHAZER

removes haze from refinery oils in a hurry!



Here's a process that has been operating with a great deal of economy in several major refineries: The Hydro Dehazer's huge rotor mixes moisture-laden oil with free air until the moisture is absorbed by the air and discharged to atmosphere. The entire cycle achieves optimum efficiency without the use of compressed air, high heat, chemicals or other additives. Capacities range to 450 bph for No. 2 fuel oil at an inlet temperature of 130°F. with a haze point of 70° depending on the consistency of the charge.

HENDRICK MANUFACTURING COMPANY
36 Dundaff Street, Carbondale, Pennsylvania

Gentlemen:

I am interested in learning more about the new Hendrick Hydro Dehazer.

☐ Please send technical data.

☐ Please arrange demonstration of the Dehazer Pilot Model.

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SEE OUR CATALOG IN THE COMPOSITE CATALOG

New Equipment . . .

consideration in the case of refinery heater tubes. Furthermore, Niphos-coated areas can, when properly welded, suffer no loss of corrosion resistance in the weld-affected area, fabrication of heat transfer units and piping systems having dependable, corrosion-resisting properties throughout should be greatly simplified. Tube Reducing Corp.

Circle E18 green card, last page

Erratum

Spraywelder and Sprayweld should have been acknowledged as trade marks of the Wall Colmonoy Corp., in the July issue of PETROLEUM REFINER.

Simple Design Methods In Heat Exchanger Catalogue

A completely revised heat exchanger catalogue has just been published.

The catalogue contains an engineering section that provides the engineer with the means to make size estimates of the heat transfer equipment to be used in his plant. Simplified charts provide him with a fast method of determining the friction factors and heat transfer characteristics of flow through the tubes.

After the necessary calculations are made, a heat exchanger may be selected that will provide economy of service, precise operation in the process and long life. Condenser Service & Engineering Co., Inc.

Circle E19 green card, last page

Electro-Hydraulic Valve Operators Use DC Current

A new line of completely self-contained Electro-Hydraulic Valve Operators has just been developed. They produce high performance without the use of electronic amplification, utilizing only simple direct current actuated force motors to operate the hydraulic pilot. Nozzle-flapper combinations are used in the pilot to control hydraulic pressure, eliminating sliding plate or spool type valves which are easily stuck.

Two series of operators are available. Type 340 can be mounted on valve sizes one-half inch to four inches and will develop stem thrusts up to 600 pounds. Type 350 can be mounted on valve sizes one-half inch to 16 inches and develops stem thrusts up to 2000 pounds. Both operators may be adapted to operate on the DC input signal from any instrument currently available. Fisher Governor Co.

Circle E20 green card, last page

Design Data Included In Steam Specialties Catalog

A completely new 58 page catalog on steam specialties has just been published. It includes complete design data on steam traps, strainers, separators, pressure regulating valves, pressure reducing valves and block steel valves. In addition, it includes charts for sizing steam supply and return piping as well as a special section on how to size steam traps. Strong, Carlisle & Hammond Co.

Circle E21 green card, last page

Three Bulletins Describe Vinyl Coating Applications

High build vinyl needs only two coats over primer to exceed customary film thickness of 5 mils. Fewer gallons to buy and apply. Protects against acids, alkalis, sales, sulfides, oils, alcohols, weather and

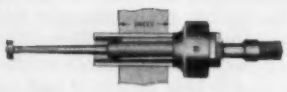
WIEDEKE

THE QUALITY NAME IN TUBE EXPANDERS . . . SINCE 1892

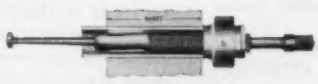
Tube Expanders for Condensers

No. 255—for average tube sheets

No. 270—for thick or multiple tube sheets



No. 255—Adjustable for sheets up to 2¼" thick



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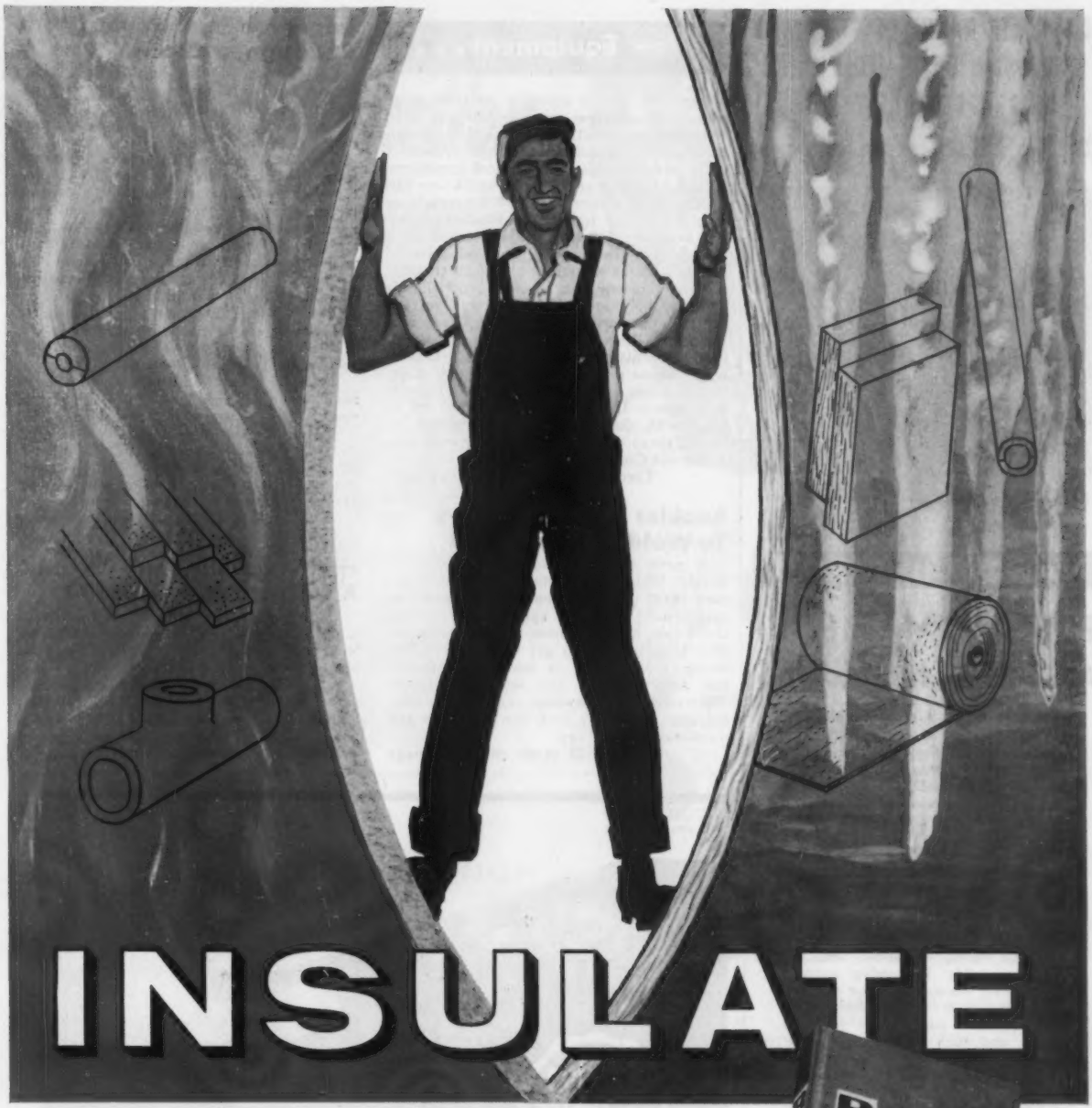
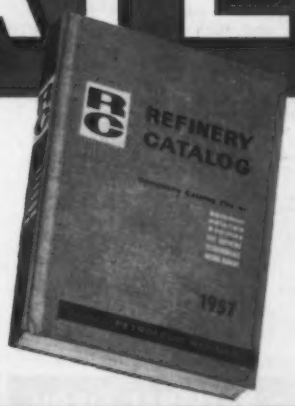
IDEAL

IDEAL Ball Bearing Tube Expanders are made of special analysis alloy tool steels, carefully heat-treated to withstand the severest operating strains. They are adaptable for use with any torque controlled tube rolling units—air, electric or mechanical. *Confidence* is your assurance that your job will be done *RIGHT* . . . when you use WIEDEKE Specialized Tube Expanders, Tube Cutters and Operating Accessories. There is a Wiedeke Distributor in every principal city. For further information write for *new* General Catalog 81.

The Gustav WIEDEKE Company

Dayton 1, Ohio





FROM 1800° F. TO SUB-ZERO WITH KAYLO AND FIBERGLAS

See your 1957 Refinery Catalog for data about the widest range of industrial insulations ever offered! Twenty pages give you the specifications you need to know about Fiberglas* and Kaylo® products.

Whatever your need, you'll find an amazing variety of plant insulations in every imaginable shape, size, and thickness. You can specify insulation for any temperature control situation from 1800° F. to sub-zero . . . and you can order them *all* from Owens-Corning Fiberglas Corp.

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*T-M. (Reg. U. S. Pat. Off.) O-C.F. Corp.
® T-M. Owens-Illinois Glass Co., Inc., mfr. of Kaylo

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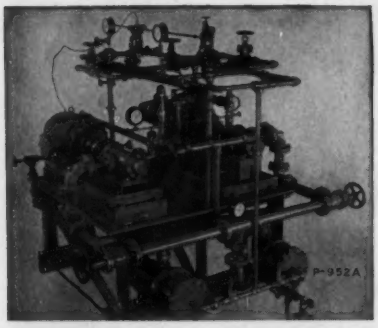
COMPLETE RANGE OF SIZES AND MODELS IN BOTH MEDIUM AND HIGH PRESSURE TYPES

MORE COMPACT THAN EVER . . .



P-952-A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

NATIONAL AIROIL

FUEL OIL PUMPING AND HEATING UNITS

NATIONAL AIROIL Fuel Oil Pumping and Heating Units are specially designed to prepare, for combustion, all grades of fuel oil including No. 6 or Bunker "C" Oil and residuums. They will draw fuel oil from above ground or underground tanks, preheat it to proper constant temperature and deliver it to Oil Burners at an even pressure, best suited for the burners. Our Fuel Oil Pumping and Heating Units are the result of years of experience. They come completely equipped ready for steam, exhaust, condensate, oil suction, oil return, and electrical connections. All valves, regulators, etc., are readily accessible. The piping arrangement is easily understood. These compact, space-saving units are available in a range of sizes and models in both Medium and High Pressure types. For complete details, write for our Bulletin 40—very interesting and informative.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
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DUAL STAGE, Combining steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
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water. Dry film is abrasion resistant, nonflammable, odorless, tasteless and non-toxic.

Decorative vinyl gives attractive appearance and outstanding weather resistance as it protects against chemical exposures. Resists chalking and fading, and keeps dirt pickup to a minimum. Used separately or as a decorative topcoat over other protective coatings. Contains mild solvents, so it can be applied over most well-adhered paints without wrinkling or lifting them.

Vinyl coating for masonry and plaster contains polyvinyl chloride resins, instead of polyvinyl acetate, in water-based formulation. Resists chemical attack and effectively seals masonry and plaster against water vapor penetration. Dry film is odorless, tasteless, non-toxic, non-flammable and non-porous. Unharmed by repeated scrubbing with detergents. Easily applied by brush, spray or roller, indoors or outdoors. Amercoat Corp.

Circle E22 green card, last page

Booklet Describes Ways To Weld Stainless Steel

A new 20-page booklet "A Guide to Better Welding of Stainless Steels" has just been issued. Intended for both the experienced and less experienced welder, the guide answers many of the questions that arise in how to get best results. The entire presentation is made in question and answer form. The booklet is freely illustrated with drawings and closeup photographs to clarify both the problems and solutions. Arcos Corp.

Circle E23 green card, last page

Improved Performance With Redesigned Chart Motors

Chart drive and two-phase balancing motors used principally in recorders, indicators and controllers have been redesigned to provide improved performance and easier servicing.

The new design features a series of four die-cast aluminum housings bolted together into a square assembly, a printed circuit that lengthens the life of coil connections, and felt wicks that prevent leakage of lubricating oils. One casting contains the stator, another the gear box, while two serve as retainers for bearings at each end of the rotor.

Any of the component parts can be inspected and serviced in a matter of a few minutes, according to the company. The two products weigh 29 ounces each.

Two-phase induction motor models have no-load shaft speeds of 330, 148, 44 and 22 rpm and maximum starting torques of 10, 20, 60 and 120 ounce-inches. Synchronous chart-drive motors have speeds of 180, 90, 60 and 30 rpm with pull-in torques ranging from 12 to 25.5 ounce-inches. Minneapolis-Honeywell Regulator Co.

Circle E24 green card, last page

High-Vacuum Pump Creates A Vacuum Electronically

Three years of research has resulted in a new, revolutionary high-vacuum pump with three times better ion pumping speed and greater dependability.

Known as the Evapor-Ion Pump, it provides an electronic method for producing high vacuum without the use of organic pump fluids. The pump is the only device available that creates a "dry" vacuum in

Your New Sealing Problem May be an Old One to Us . . .

FREE ENGINEERING COUNSEL . . . We invite you to submit details on your sealing needs.

FOR 40 YEARS Durametallic has built up an extensive Service Record File. It covers answers to hundreds of specific sealing problems. In all probability we have the answer to your sealing problem in this "success" file.

DURAMETALLIC CORPORATION
The PERFECT SEAL
KALAMAZOO MICHIGAN

Plibrico Construction

THE "pro" OF proficient INSTALLATION

Follow-thru . . . that's the something extra which distinguishes the expert, be it in golf, tennis, fly casting, or baseball.

In refractories, quality products and capable engineering are fine, as far as they go. But for that something extra, your Plibrico distributor follows thru with his highly skilled, specially trained installation crew. The simple fact is they know exactly what they're doing when they install refractory linings in refining process equipment. And they do it well.

Proficient installation makes your Plibrico distributor's service truly complete. Products, engineering, and installation are yours from a single supplier, with responsibility undivided. Next time have the complete job done by your Plibrico man.

Plibrico REFRACTORIES ENGINEERING CONSTRUCTION

PLIBRICO COMPANY • CHICAGO 14, ILL.
Plibrico Sales & Service in Principal Cities

So SIMPLE We Can Adapt It to ANY LIQUID LEVEL CONTROL JOB

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

MAGNETROL

AS DEPENDABLE AS MAGNETIC FORCE ITSELF

● No matter how specialized the liquid level control application, adapting Magnetrol to meet it presents no problem. Whether it's for high pressures, high temperatures, corrosive liquids or any other condition, a few "standard" modifications and the job is done! Operation is so simple no changes in basic design are needed. That's why Magnetrol "fits" practically any application — why "specials" are so often standard with us.

Because of the utter simplicity and dependability of its magnetic principle, Magnetrol has *infinite operating life.* There are no wearing parts to get out of order.

Magnetrols are available for controlling level changes from .0025-in. to 150-ft., with single or multi-stage switching. Our experienced engineering staff is at your service.

MAGNETROL, Inc.

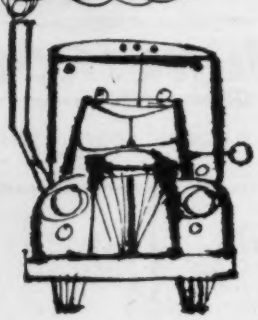
WHY NOT MAIL THE COUPON — NOW

Magnetrol, Inc., 2112 S. Marshall Blvd., Chicago 23, Illinois
Please send me catalog data and full information on Magnetrol Liquid Level Controls. 7

Name_____
Company_____
Address_____
City_____ Zone____ State____

For more data on advertised products, use Readers' Service Cards, last page.

pull more diesels to your pump –deliver full power without noxious exhaust odors –just add Alamask® to your diesel fuels



It takes very little Alamask to subtract the choking odor from diesel exhaust fumes while adding to your sales. Alamask in your fuel will pull truckers, bus operators to your pump. *Selling point to truckers:* operators who tank up with your odor-controlled diesel fuels avoid the increasing demands to "put a stop to engine odors or reroute your lines." *Selling point for buses:* lines that standardize on your odor-controlled fuel increase passenger comfort both in the vehicle and in the terminal—builds good will all along the route. Why not call us about adding Alamask to your diesel fuels? Let us show you how Alamask can give you a new competitive plus.

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New Equipment . . .

the range from 10^{-4} to 10^{-8} mm Hg. It pumps active gases by the gettering action of evaporated titanium wire, and pumps inert gases by ionizing and burying them under a layer of titanium.

Continuous titanium wire evaporation is assured by an improved feeder mechanism. Operation is now possible for periods up to six months or longer without breaking vacuum for pump servicing. A power supply cabinet provides three times the accelerator grid current formerly possible and permits much easier starting of the pump by simultaneous power application to the electrodes and firing of the primers used for roughing out. These primer charges now have a combined absorption capacity of 360,000 micron-liters of active gases. Rochester Division, Consolidated Electrodynamics Corp.

Circle E25 green card, last page

Packing Applications Shown On Guide Chart

Prepared as a four-page folder that can be mounted as a chart is this general guide on packing applications by temperature range, type of liquid being handled and type of equipment being packed. Especially designed for refining and petrochemical applications the chart also includes illustrations and gives material specifications of the principal types of packings available from this manufacturer, James Walker & Co., Ltd.

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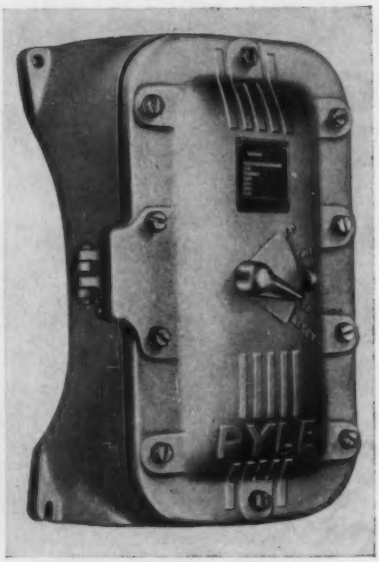

Air-Break Type Explosion-Proof Enclosures Announced

A new line of explosion-proof, dust-tight and weather-resistant (rain-tight) Circuit Breaker Pylets is now available. Designated the ECB Series, enclosures are available for breaker frame sizes from 100 Amp., 250 volts AC maximum to 225 Amp., 600 volts AC maximum. Of the air-break type, they are suitable for use in Class I, Group D (NEMA type VII);

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will PURCHASE
or REFINE . . .
for your account.

The facilities and experience of Truland may be employed advantageously for the economical upgrading and disposal of solvent mixtures and organic by-products.
Our technically trained personnel are available to discuss the refining of any solvent mixture or organic by-products.

Send for new booklet which describes our operation

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REGENERATES IN SITU!

Higher octane levels and longer catalyst life... with existing equipment ...merely by replacing with Sinclair-Baker RD 150 Platinum Catalyst

If you have the problem of increasing octane rating and production in your existing equipment, investigate the unique performance of Sinclair-Baker RD 150 Platinum Reforming Catalyst. Its efficiency in producing *important yield increases at high octane levels* is a matter of record. The long period of RD 150 operation is unmatched by any other catalyst... further, *it is regenerative in situ!* Cost is sharply reduced to lowest level.

A Baker representative will be glad to give you detailed information, upon request. All data of confidential nature are of course treated accordingly.

BAKER & COMPANY, INC. CATALYSTS

BAKER & CO., INC.

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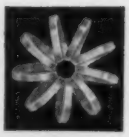
ENGELHARD INDUSTRIES

Partition Ring

Spiral Ring



Plastic Tellerette

Lessing Ring

Raschig Ring

Ceramic Berl Saddle

SPECIALISTS in Tower Packings

Here are several types of tower packing made in one of the Knight plants, the largest in the country specializing in tower packing production.

Knight packing includes the popular and efficient Berl Saddles made of unglazed porcelain and chemical stoneware. Both are sturdy, nonspalling and entirely acid proof. Berl Saddles, made of Permanite or steel, are available for use with strong caustic solutions or HF.

Knight makes other tower packings — including Raschig, Lessing, spiral, and partition rings. We also furnish the new polyethylene Tellerette packing shown.

Data concerning sizes, weights, surface area, etc., on our various types of tower packings is given in Knightware Chemical Equipment Bulletin No. 11 — Write for your copy.

Maurice A. Knight

956 Kelly Ave., Akron 9, Ohio

KNIGHT-WARE CHEMICAL EQUIPMENT

New Equipment . . .

Class II, Groups E, F and G; and Class III (NEMA types IX, V, III) hazardous locations.

The compact, rectangular shape of the enclosure permits mounting adjacent units on extremely close vertical and horizontal mounting centers. The Ferrous alloy enclosure is cadmium-plated throughout, including the flame arresting, ground surfaces of the housing-cover joint which will not, therefore, corrode or seize. A snap-in gasket for this joint is furnished to make the explosion-proof and dust-tight enclosure weather resistant as well. The single, hinged front cover gives complete access to the circuit breaker thus simplifying installation and maintenance and permitting direct wiring with a minimum of bending. The Pyle-National Co.

Circle E27 green card, last page

Carbon Brush Performance Discussed In New Booklet

Getting the best performance out of carbon brushes is the theme of a new booklet just published.

The 8-page booklet contains question-and-answer interviews with George H. Gunnoe Jr. covering brush life, metal transfer, commutator threading, bar marking, and commutator adjustment.

Gunnoe, senior application engineer in the company's Carbon Products Sales section, Large Motor and Generator department, is an expert on commutation problems. General Electric Co.

Circle E28 green card, last page

Recently Introduced Instruments In Bulletin

Instruments introduced within the last year have been included in new 8-page bulletin. Applications, ranges, and detailed literature references are given for complete line of transmitting, recording, indicating, and controlling instruments. Bailey Meter Co.

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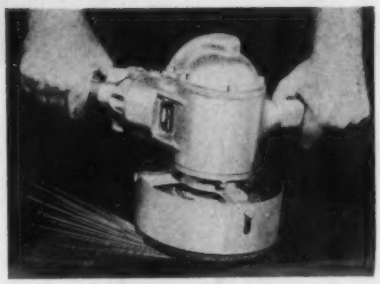
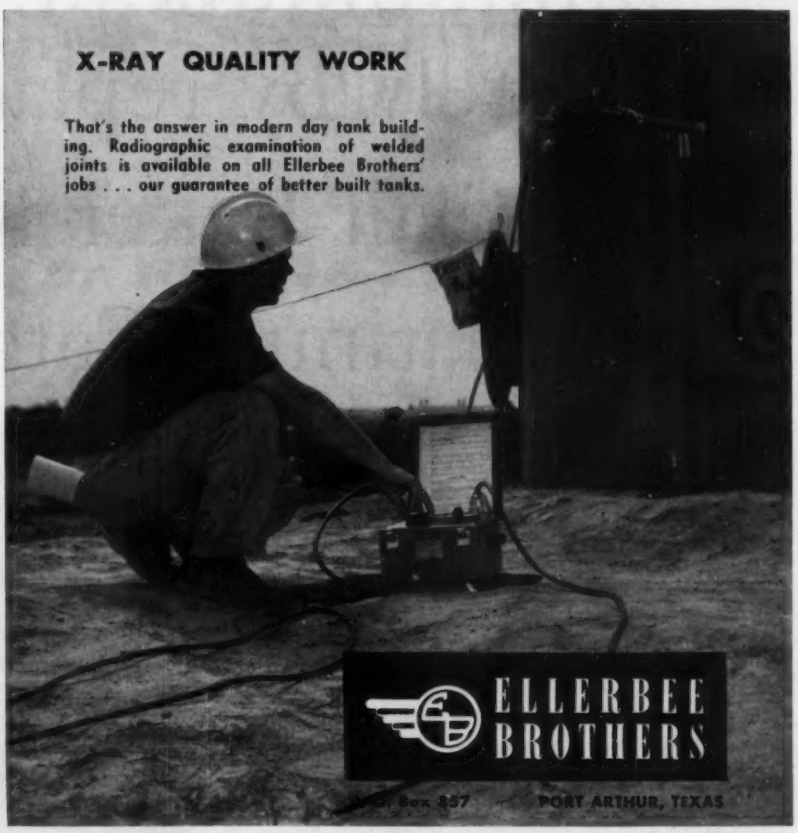


Grinder Ideal for Flat Or Curved Surfaces

A vertical pneumatic grinder which can be used for cup wheel grinding, sanding or wire wheel work, has recently been designed.

The vertical pneumatic grinder with its six-inch cup wheel, wire brush or flexible sanding disc has been proved the ideal tool for taking down rough spots or over-all grinding on flat or curved surfaces. Equipped with two handles, it is easy for the operator to maneuver the grinder and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That's the answer in modern day tank building. Radiographic examination of welded joints is available on all Ellerbee Brothers' jobs . . . our guarantee of better built tanks.
ELLERBEE BROTHERS
Box 857 PORT ARTHUR, TEXAS

POSEY PRESSURE VESSELS

These twin tanks were fabricated by POSEY for propane storage for a South American industry. Each tank is 34′ long and 10′ in diameter. Fabricated from 1″ steel plate, these tanks operate at pressures up to 250 pounds per square inch.

POSEY pressure vessels are in service in most civilized parts of the globe. With almost a half-century of experience, Posey is well equipped to design, fabricate and erect pressure vessels of all types and sizes . . . of steel or alloy steel . . . for liquid or gas.

Posey pressure vessels are tested to considerable excess over normal working pressures. All standard codes are met, including ASME and API-ASME.

Let POSEY quote on your next pressure vessel job. Quotations and other information upon request without any obligation.

POSEY IRON WORKS, INC.
STEEL PLATE DIVISION **LANCASTER, PENNA.**
New York Office: Graybar Building
Established 1910

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Let Southern Engine & Pump Company show you how Viking Pumps can solve your pumping problems. We invite your inquiries.

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■ Efficient, compact STRAUB Gas Generators are available in three basic types—endothermic, exothermic and nitrogen. A wide variety of styles and sizes meet every need. If you have a gas blanketing or controlled atmosphere problem . . . write for this helpful catalog.

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ENGINEERED INSULATION by MUNDET

The difference between two kinds of insulation may be many years of trouble-free service . . . an advantage that may far outweigh the initial cost factor.

Mundet engineered insulations are precision-manufactured to serve you for your individual requirements . . . longest . . . best!

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MUNDET INSULATION PRODUCTS

include "custom-molded" 85% Magnesia heat insulation and "Tri-Calite" insulation for higher temperatures. Also Mundet's Expanded Polystyrene Pipe Covering and Mundet's Expanded Polystyrene Board Insulation, and Corkboard and Cork Pipe Covering for low temperatures.

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28-42 OGDEN ST. NEWARK 4, N.J.
WORKING PRESS:- SHELL TUBES
UNIT NO. JOB NO.

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THIS NAMEPLATE IS YOUR GUARANTEE OF QUALITY

- Condensers
- Evaporators
- Jacketed Kettles
- Ribbon Mixers
- Agitators
- Reactors
- Pressure Vessels
- Heat Exchangers
- Reboilers

M & L CARBON STEEL STRIPPER

MATERIALS: All Carbon Steel Body except the #304 Stainless Steel Head
PHYSICAL DIMENSIONS: Over-all Height 23' Four Sections each 4' Long —18" Dia. Top Section 4' Long—30" Dia.
WEIGHT: 3800 lbs. (Empty)

Here is another example, among the thousands of case histories in our files, of how Manning & Lewis clearly and logically interpret customers requirements . . . from original concept to finished quality product.

Both the saving in time and cost resulting from our years of engineering experience are two important factors why more and more manufacturers are turning to M & L.

Why not call on us the next time you need equipment. We design and construct to A.S.M.E. or A.P.I. code for unfired vessels or we can build to non-code standards.

Please state all conditions of service so that we will be able to handle your inquiry promptly and accurately.

Manning & Lewis *Engineering Company*
DESIGNERS & MANUFACTURERS OF QUALITY HEAT EXCHANGE EQUIPMENT
28-42 OGDEN STREET NEWARK 4, NEW JERSEY

New Equipment . . .

keep it under control in any position and at any speed.

It weighs only 11 pounds and is balanced to grind evenly and smoothly with little added pressure at speeds from 4500 to 6000 rpm. An easy to adjust thumb button control makes it simple to adjust the grinding speed quickly.

A wide variety of large cutting surface wheels, sanding and polishing attachments are available for this tool, making it useful for a wide range of work. The Airetool Manufacturing Co.

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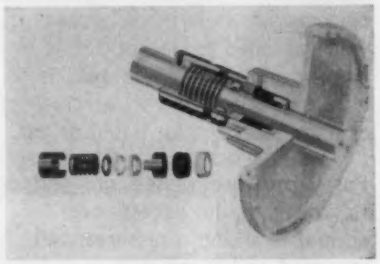

These Mechanical Seals Have Interchangeable Parts

Now available is the first line of both external and internal mechanical seals with interchangeable parts for any given shaft size. With the exception of the stator bushing, identical in size and shape, but of different materials, the parts of "Wedge-Lock" seals are interchangeable. This important cost and time-saving feature results in:

- Savings through reduction in spare parts.
- Greater protection against pump down-time.

Chempro "Wedge-Lock" seals are economical on pumps handling acids, caustics and other liquids and slurries at temperatures from —80 F. to 500 F., from vacuum to 100 psi. Seal faces are always within the stuffing box, eliminating dangerous spray hazards. Flushing, cooling and/or lubricating can be supplied on all seals. Chemical & Power Products, Inc.

Circle E31 green card, last page

Small Particles Measured By New Principle

One of the more difficult analysis measurements has been the size distribution of microscopic particles in the 1-100 micron range. Blood cells are in the 5-10 micron range, and as sometimes happen, an instrument originally developed for the medical-biological field is making a large contribution to the advance of industrial measurements.

There is a widespread and vital need for particle content and size distribution measurement of slurries, dusts, crystals, flours and many similar materials. Until recently, the principal apparatus has been microscopes and sedimentation tubes, utilizing human and/or automatic means for measuring slide counts and settling rates respectively.

A new principle involves the forced passage of a fluid suspension of particles through a small aperture having an elec-

STRATCO

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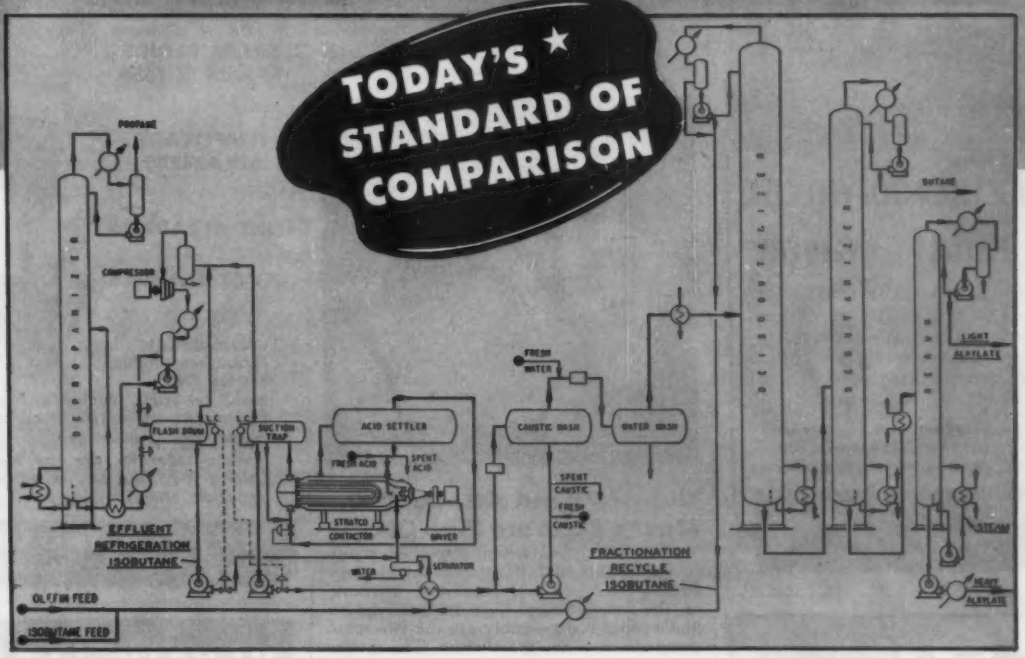
SULFURIC ACID ALKYLATION



With an Amazing 5 Year Installed Capacity Record

Evidence of the advantages of Stratco H_2SO_4 alkylation is in the table at the right, graphically depicting the position of Stratford Engineering Corporation in the alkylation field. This record, and it is a record for the industry, is the result of proven superiority in yield and quality of product, economy of acid consumption, initial investment and operating costs.

The Stratco Effluent Refrigeration Process is the most efficient process available for producing alkylate and may be used to process propylene, butylene or amylene, either separately or as combined streams.

Electronic Computation, Too

Just send us your data for electronically computed process flow diagrams and complete overall heat and material balances best suited to your operation ... ordinarily available within 48 hours.

Representatives

D. D. Foster Co., Pittsburg • Lester Oberholtz, Los Angeles
Rawson & Co., Houston, Baton Rouge • F. J. McConnell Co., N.Y.

Stratco Effluent Refrigeration licensed by Stratford Engineering Corporation. We cooperate with your contractor in plant design.

Stratco H_2SO_4 Alkylation Units
July 1, 1952 .... July 1, 1957

Location	Approx. Design Cap. BPSD	Units
Texas City, Texas	7500	5**
Watson, Calif.	3000	2*
Amarillo, Texas	950	1
Eagle Point, N. J.	2100	2
Lawrenceville, Ill.	2100	2
Puerto Rico	1400	1
Houston, Texas	6300	4
Hattiesburg, Miss.	2650	2
Toledo, Ohio	1500	1
Beaumont, Texas	7900	5
Sugar Creek, Mo.	3900	2
Kent, England	2500	2
Trenton, Mich.	3600	2
Toledo, Ohio	1500	1
Atreco, Texas	2100	2
Anacortes, Wash.	2400	2
Anacortes, Wash.	2100	2
Formosa	900	1

**Closed cycle refrigerated revamp of a 5000 BPSD auto-refrigerated installation.

*Closed cycle refrigerated. All others Stratco effluent refrigerated.

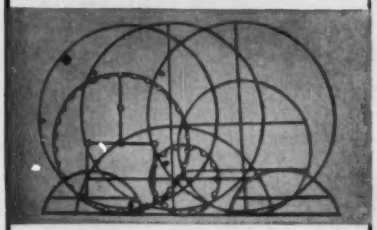
This list does not include 139 units furnished for alkylation service prior to effluent refrigeration development.

STRATFORD ENGINEERING Corporation

612 West 47th St. — PETROLEUM REFINING ENGINEERS — Kansas City 12, Mo.

For more data on advertised products, use Readers' Service Cards, last page.

Need GASKETS for HEAT EXCHANGERS?



Call CHICAGO-WILCOX for PROMPT DELIVERY

Here is a dependable source for gaskets for heat exchangers. These gaskets can be made in any size or shape as needed—cut from solid metal, sheet-packing; also double jacket type.

Send specifications, blue prints or templates, for quotation and a prompt-delivery schedule for normal stocking orders.

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Phone: SAginaw 1-1900

COPALTITE

Plastic Gasket & Pipe Thread SEALING COMPOUND

•

EXCELLENT FOR STEAM TURBINES

•

JOINTS EASILY TAKEN APART WHEN USED AT 1700° TEMPERATURE AND 1800 LBS. PRESSURE

•

Replaces expensive gaskets
Easily applied
Economical
Ready for use in paste or liquid form

•

Resists steam, gasoline, oil, alcohols, ammonias, acids and mild alkalis as well as most other reagents.

WRITE FOR LITERATURE AND PRICES

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Houston, Tex.

Manufactured by
NATIONAL ENGINEERING PRODUCTS, INC.

New Equipment . . .

trode on each side. As a particle passes through, aperture resistance changes in proportion to particle size, and the resultant series of electrical pulses is electronically scaled and counted. In apparatus now available curves of cumulative particle frequency vs. particle size are obtained directly. Weight and area distributions are readily derived from these. Coulter Industrial Sales Co.

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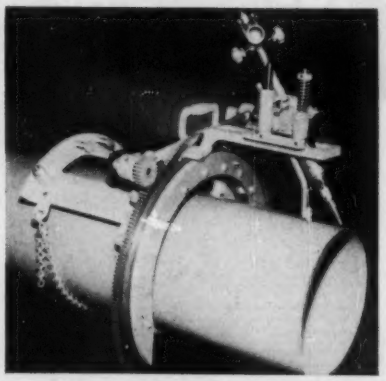

Out-of-Round Attachment Makes Accurate Pipe Cuts

Announcing a new and improved design in the "out-of-round" attachment for pipe cutting and beveling machines. Working on the spring-tension principle, the spring and a roller rod assembly are the two main components of the attachment. The special attachment is engineered to eliminate the problem of inaccurate cuts or bevels on "out-of-round," or imperfect pipe.

The roller rod assembly consists of a rod that is fastened to the body of the attachment by means of a set screw arrangement, and a small diameter wheel that is affixed to the end of the rod, which travels the outer circumference of the pipe surface. Through the action of the spring, constant pressure is applied to the roller rod, which forces the wheel to follow the contour of the pipe. This maintains the torch equidistant from the pipe at all times, thus correcting for any defects in the surface. H & M Pipe Cutting and Beveling Machine Co.

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Catalyst Reduces Sulfur In Petroleum Fractions

A new desulfurization catalyst, an extruded cobalt-molybdena catalyst called AERO HDS-2 reduces the sulfur content of petroleum fractions by conversion to hydrogen sulfide. The catalyst has good mechanical properties and especially high activity.

Extensive laboratory and field performance data show greater sulfur and nitrogen removal efficiency than other cobalt-molybdena types. Higher active metals content, superior porosity and low bulk density are also cited as significant improvements over existing compounds.

The low bulk density combined with high activity means refiners can now treat the same throughput with fewer pounds of catalyst (up to 30 percent less) or increase throughput on the same quantity

SANDUSKY MAC-IRON OHIO
ESTAB. 1901

SPECTACLE BLINDS

SPADE BLINDS
SPACER RINGS

TEMPORARY STRAINERS

LINE STRAINERS

PIVOT FLANGES

Specialists to the Petro-Chemical Engineering Field . . . based on scope, quality and service. Equipment available from stock, or made to your exact requirements.

Write today for the new Mac-Iron Catalog A-7. Your request will receive immediate attention.

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Warren and Water Sts. - Sandusky, Ohio

REPAIR LEAKS
QUICKLY—PERMANENTLY

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure—without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.

SKINNER-SEAL COLLAR LEAK CLAMP—designed to stop every type of collar leak in oil and gas lines. Sizes: 2" to 13" inclusive.

M. B. SKINNER COMPANY
SOUTH BEND 21, INDIANA, U. S. A.

Yes, we can handle your job...

SERVICE FOUNDRY

Our foundry and machine shop are geared to the special needs of the petroleum refining industry—and our production tools are the finest. As Avondale's foundry division, we have shared in the diversification and expansion of the industry as a whole. We are prepared to offer you a complete service—from engineering through the finished job. Next time, make it a point to call for "SERVICE" . . .

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a division of AVONDALE MARINE WAYS, INC.

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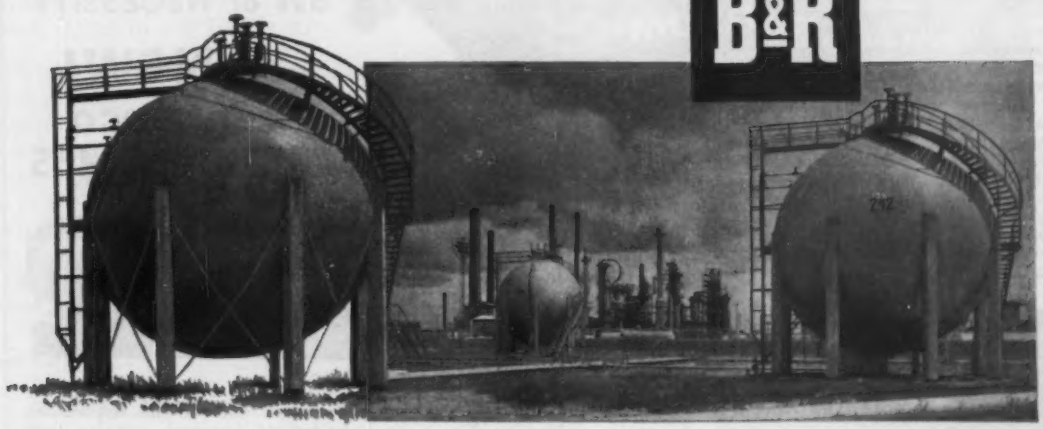

Oil refineries

in many countries successfully equipped their modern plants with B&R Gate Valves, Globe Valves, Swing Check Valves, Safety Valves. B&R Valves are manufactured according to API specifications. Flange dimensions conform to ASA. Materials correspond to ASTM. One trial with our Valves will make you our customer for ever. Please ask for B&R catalog We 110e with detailed particulars on our lines of **oilfield and refinery equipment.**

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GERMANY

Oe 649 e

For more data on advertised products, use Readers' Service Cards, last page.

PENFLEX TUBING

ADDS LEAKPROOF FLEXIBILITY

TO RIGID TANK LINES

Moving slowly with expansion, contraction and settling of storage tanks or riding out the tide in unloading tankers, Penflex Tubing has proved its flexibility. It "gives" with temperature changes and settling without breaking . . . withstands crushing, abrasion, exposure . . . yet it stays as tight as a pipe, prevents dangerous leaks and seepage.

Whatever your tubing needs—for oil field, refinery, bulk plant, transportation equipment—let Penflex meet them with *flexible*, corrugated or interlocked tubing available in bronze, galvanized or stainless steel tubing in sizes from 1/8" to 24" I.D. For full data write Pennsylvania Flexible Metallic Tubing Company, Inc., 7207 Powers Lane, Phila. 42.

GET YOUR COPY of this practical, helpful guide to flexible tubing.

PENFLEX

TIGHT AS A PIPE BUT...

FLEXIBLE

New Equipment . . .

of catalyst—and without a drop in treating level.

Designed for service in both new and existing facilities, the new catalyst is said to regenerate easily with little loss of activity or crush strength. American Cyanamid Co.

Circle E34 green card, last page

Booklet Helps You Select Equipment for Nuclear Lab

A 28-page booklet giving complete coverage to the selection of nuclear laboratory equipment and picturing a complete line of counting, sample preparation, personnel protection and survey, "hot lab" and storage equipment as well as complete reference standards, has been published. The booklet features two comprehensive tables, one of which gives the efficiency, speed, and other vital information on all detectors listed in the tables. The second table compares the features of the various scalers and shows the accessory equipment with which they may be operated.

Photographs of complete composite units representing the total nuclear instrumentation requirements for typical applications help in the selection and coordination of laboratory equipment. Tracerlab Inc.

Circle E35 green card, last page

New Digital Computer Is Office Desk Size

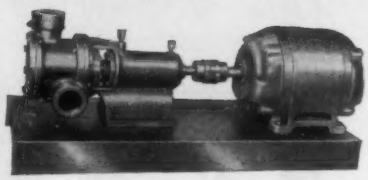
No larger than an office desk, the RW-300 digital control computer is the first computer designed to automatically control a wide variety of manufacturing processes, including chemical manufacturing, oil refining, metals processing and paper manufacturing. "Clean" packaging design of the RW-300 is shown in this photograph, the first to be released of the new control computer. It measures only

by PROGRESS
out of NECESSITY

The **NEW!**

AURORA® APCO

Z4 *Process* PUMPS



for
HANDLING LIQUEFIED PETROLEUM GASES, REFRIGERANTS *and other* NON VISCOUS LIQUIDS *of* MODERN INDUSTRY

AURORA *Always* PUMPS

Modern industry offers a challenge in the form of new and difficult applications which demand improved pumping techniques. In the Type Z4 APCO Turbine-Type Pumps will be found the complete answer to many of the applications involving liquefied gases and other light, non-viscous liquids. Obtainable in special metals with notable economy.

***Write for* BULLETIN 111-ZA**

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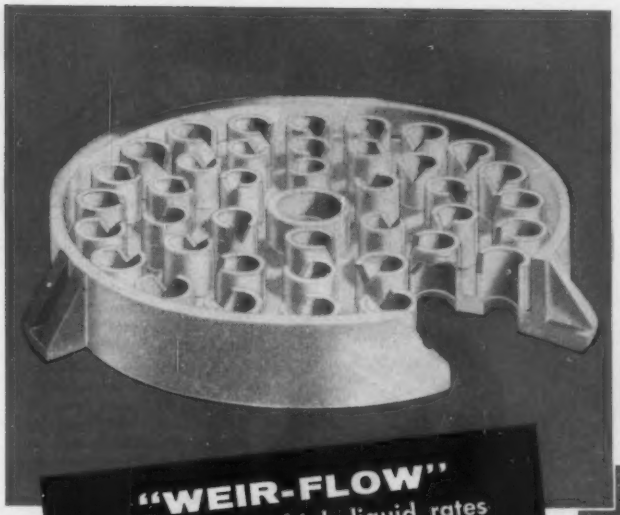
AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY

84 LOUCKS STREET • AURORA • ILLINOIS

EXPORT DEPARTMENT — Aurora, Illinois — Cable Address "NYABINT"

TWO NEW TOWER DISTRIBUTORS



"WEIR-FLOW"
for medium-to-high liquid rates

The development of newer tower packings (such as Intalox Saddles and Metal Pall Rings) brought into sharp relief the need for better liquid distributors to permit full utilization of the better performance characteristics of these packings.

U. S. Stoneware developed, pilot-plant and field-tested, a number of distributors. Two, in particular, showed far superior operating characteristics, and are now offered as standard items in our line.

The "WEIR-FLOW" Distributor: Cylindrical risers with "V" notches are used as downcomers for the liquid, permitting greater flow as the head increases. Provides uniform liquid distribution over a wide range of medium to high liquid rates. Made in chemical stoneware and chemical porcelain in a range of sizes to fit towers up to 8 feet in diameter; also in carbon steel or stainless steel for towers as small as 6" i.d., and in larger diameters to fit customer's specifications.

"MULTI-LEVEL"
for low-to-medium liquid rates

The "MULTI-LEVEL" Distributor: Essentially a tray with a perforated bottom, but the perforations drain at three different levels. Provides uniform liquid distribution over a wide range of low to medium liquid rates. Made in chemical stoneware and in chemical porcelain for towers from 24" to 60" in diameter.

SEE THEM AT THE CHEM SHOW, NEW YORK COLISEUM, DECEMBER 2-6, BOOTH 111

102-F

New Booklet on SUPPORT PLATES and DISTRIBUTORS

New 24 page booklet just off the press describes our complete line of support plates and distributors. Write for it today. Ask for Bulletin TA-30.

U. S. STONEWARE

AKRON 9, OHIO

For more data on advertised products, use Readers' Service Cards, last page.

WHEN SPECS CALL FOR...

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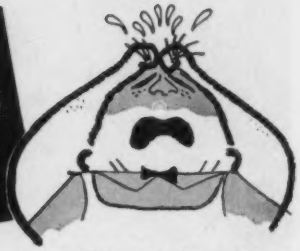

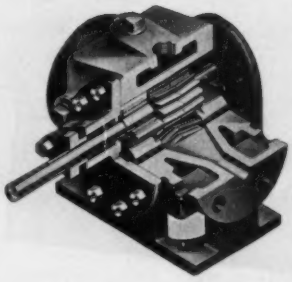

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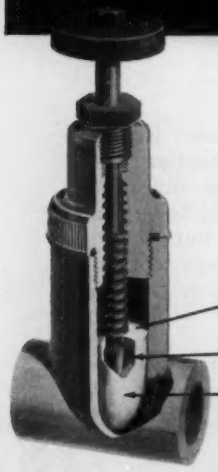

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½"-2" sizes

- No-pressure-drop construction of gate valve
- Throttling flow-control feature of globe valve
- PVC or styrene-copolymer construction
- Handles wide range of corrosives and slurries

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*Pat. Pending

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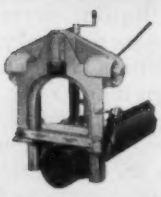

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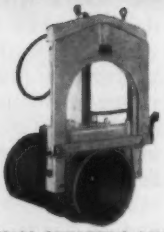

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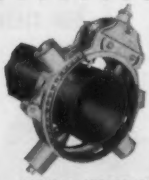

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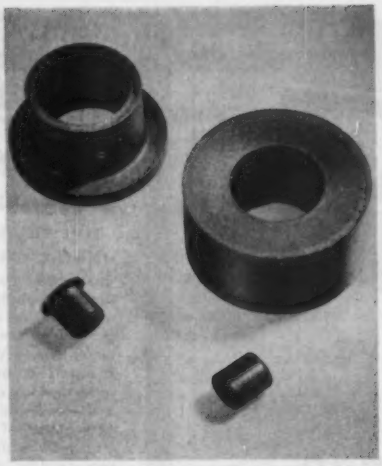

Lube Problems Licked With Bearing Material

A new bearing material has been developed for applications where lubrication is a problem. This composite material, known as Chemloy, is especially recommended for dry bearing services, both sliding and rotating at temperatures up to 500 F. Due to its properties, it is ideal for use with solvents, such as acetone and practically all types of corrosives. It is also excellent for applications subject to impact, since it will not permanently deform due to shock. This property is especially important in mechanical linkage assemblies, where constant vertical and horizontal impact is present.

Chemloy has a static or kinetic coefficient of friction against polished steel of only 0.04 and a P.V. factor up to 10,000. It will withstand speeds up to 1000 fpm. and loads to 100 psi. Crane Packing Co.

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Wall Chart Describes Properties of Steel Bars

A handy 11-inch x 17-inch wall chart showing all AISI grades of cold finished steel bars is now available. This new 5-page comparison chart lists the 241 grades of steel bars which satisfy more than 95 percent of all current specifications as well as their complete chemical analysis. Machinability ratings are also given in surface feet per minute or as a percentage rating compared to AISI Grade B1112.

The chart covers eight AISI Grades of

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The Alumicoat Molten Aluminum Process will substantially reduce down time and expense for repairs and replacements by preventing high temperature hydrogen-sulfide corrosion and scaling in hydro-desulfurizing equipment.

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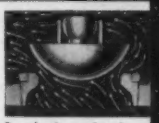
FEATURES

- No springs to force valve to seat.
- No crossbars in seat to restrict flow.
- Valve cannot bind in any position.
- Releases and seals flow instantly.



- Round valve surface is streamlined. No obstructions to restrict the flow.

- Ball-guided valve rotates and swings with each stroke of the pump. Each turn, each swing ... a continuing perfect seat.

- Free vertical action assures instant opening and closing. Ball stem is a frictionless guide.

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There is also a table of weights, which gives the weights in pounds per foot for round, square, and hexagon steel bars of thickness or diameters from 1/32-inch to 6 inches. La Salle Steel Co.

Circle E38 green card, last page

Saran-Lined Systems Handle Corrosive Fluids

A new saran lining for pipe, valves, pumps and fittings used by industry in handling corrosive liquids and gases, has been developed.

In addition to having saran's singular immunity to chemical and abrasive attack, the new lining has a 50 percent reduction in its coefficient of thermal expansion. It therefore expands and contracts to approximately the same degree as its steel casing. This makes possible its use in a wider range of temperatures.

Operations from well below zero up to 200 F. can be handled by the new lining without damage. Field tested for 18 months under extreme variations in temperature, the lining also shows improved impact resistance.

Complete saran-lined piping systems now are possible with the recent introduction of saran-lined centrifugal pumps.

Standard stock sizes of pipe, valves, pumps and fittings with the new lining are available from inventory at no increase in price. The Dow Chemical Co.

Circle E39 green card, last page

New Equipment . . .

Lubricant Recommendations For Plug Valve Service

New 16 page illustrated catalog gives lubricant recommendations for nearly 4000 service conditions for which lubricated plug valves can be used. This catalog, section 5A of reference book 39, also shows lubricated plug valve accessories, fittings, automatic lubricators, lubricant guns, and gives full information for choosing and ordering correct lubricants. Homestead Valve Manufacturing Co.

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Liquid Lock Washer Stops Loosening of Nuts

Breakdowns in mechanical equipment caused by loose nuts and bolts can now be eliminated with this new "liquid lock washer." Called Loctite sealant, this liquid plastic sets up nuts and bolts so securely that no amount of vibration will shake them loose, yet they can be removed with ordinary tools. It replaces lock washers and lock nuts, giving up to five times the removal torque of these devices.

In addition to its use to lock nuts and bolts against vibration, the unusual properties of this sealant make it ideal for sealing joints or porous welds in piping and process equipment against leakage. Maintenance and installation work on gas lines, oil burners, and ordinary plumbing can benefit greatly by the use of these handy thread locking kits of Loctite sealant. American Sealants Co.

Circle E41 green card, last page

Advertisers in This Issue

PETROLEUM REFINER, NOVEMBER, 1957

* The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1957 Refinery Catalog.

A

*ACF Industries, Inc. 78, 433
*ADSCO Division, Yuba Consolidated Industries, Inc. 20, 401
*Aerovent Fan Company Large Propeller Division 467a
*The Air Preheater Corp. 447a
*Air Products, Inc. 166
*Airetool Manufacturing Co. 452
Allied Chemical—Nitrogen Division .. 90
Allied Chemical & Dye Corp. 127, 419
*Allis-Chalmers Manufacturing Co. 46-47, 49, 51
The Allpax Co. 427
*Aluminum Company of America 24, 445, 462-463
Amercoat Corp. 59
American Air Liquide 143
American Cast Iron Pipe Co. 26
*American Chain & Cable Co. R-P & C Valve Division 426
American Copper Sponge Co. 346
American Cyanamid Co., Refinery Chemicals Department 134-135
*American Machine & Metals, Inc. ... 403
*American Recording Chart Co. 388
American Steel & Wire Division United States Steel Corp. 82
Amoco Chemicals Corp. 435
Anaconda Wire & Cable Co. 148
Anders Lykens Corp. Division Milton Roy Co. 351
Arcos Corp. 441
Armco Steel Corp. 48
Armstrong Machine Works 32
Atlas Powder Co. 131
*Aurora Pump Division The New York Air Brake Co. 484b
Austin-Western Works Baldwin-Lima-Hamilton Corp. 160
*Autoclave Engineers 402
Avondale Marine Ways 483a

B

*B-I-F Industries, Inc. 191
*The Babcock & Wilcox Co. 156, 429
The Babcock & Wilcox Co. Tubular Products Division 150
*Badger Manufacturing Co. 27
Baker & Adamson, General Chemical Div., Allied Chemical & Dye Corp. .. 127
Baker & Co. 477
*Baldwin-Hill Co. 73

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Advertisers in This Issue

Continued from Page 489

Baldwin-Lima-Hamilton Corp...160, 488b
Barrett Manufacturing Co.....466b
*The J. B. Beaird Co.....44
Belmont Packing & Rubber Co.....423
Bethlehem Steel Co.....352
*Bigelow-Liptak Corp.....139-142
The Bird-Archer Co.....432
*Black, Sivalls & Bryson, Inc.....107
*Blaw-Knox Co.....34, 144, 395
Bopp & Reuther, G. m. b. H.....483b
*Botfield Refractories.....421
Brazzil Tool & Dye Shop.....487a
*Bridgeport Brass Co.....89
British Ermeto Corporation Ltd...104Cb
Bucyrus-Erie Co.....145
*Buell Engineering Co.....180
*Buffalo-Eclipse Corp.....468
Burgess-Manning Co.....467b

C
*Calumet & Hecla, Inc.....337, 338
*Cameo Products, Inc.....353
*The Cape Asbestos Company Ltd....103
*G. O. Carlson, Inc.....61
Carter-Waters Corp.....487b
*Catawissa Valve & Fittings Co.....415
The Centrifix Corp.....101
The Champion Rivet Co.....413
The Chapman Valve Mfg. Co.....164
Chase Brass & Copper Co.....115
*Chemical Construction Corp.....176
Chemical Industries Exposition.....366
*Chicago-Pneumatic.....30-31
*Chicago-Wilcox Mfg. Co.....482a
*Chiksan Co.....80
*Childers Manufacturing Co.....12
*Clark Bros. Co.....75
The Clark Manufacturing Co.....404
Classified Advertising.....446
The Cleveland Wire Cloth Mfg. Co.....350
Cockburns Ltd.....104Ba
Columbia-Geneva Steel Division United States Steel Corp. 82, 147, 335, 417
Combustion Engineering.....84-85
Conoflow Corp.....136
C. Lee Cook Co.....63
Cooper Alloy Corp.....9, 486b
*The Cooper-Bessemer Corp.....66-67
*Coppus Engineering Corp.....60
*Corning Glass Works.....336
Cosasco Division Perfect Circle Corp.....390
Crane Co.....331
Crane Packing Co.....348
Crescent Insulated Wire & Cable Co.....444
Crouse-Hinds Co.....153
Cuno Engineering Corp.....400
Curtiss-Wright Corp.....154

D
Davison Chemical Co. Division W. R. Grace & Co.....431
*Daystrom, Inc.....390
Dempster Brothers, Inc.....149
Dicalite Division Great Lakes Carbon Corp.....382
The Dix Co.....482b
*Dollinger Corp.....58
*Dorr-Oliver, Inc.....62
Dowell Incorporated.....183
*Dresser Industries, Inc.....75, 94
*The Ducon Co.....425
E. I. du Pont de Nemours & Co.....186, 439, 440
*Duralumin Corp.....474b
The Duriron Co.....394

E
The Eagle-Picher Co.....126
*Eastern Industries, Inc.....169
Eastman Chemical Products, Inc.....461
Thomas A. Edison Industries.....8
Elforbes Brothers.....478b
*Elliott Co.....22-23, 341
*Engineers & Fabricators, Inc.....95
Enjay Co.....96
Esso Research & Engineering Co.....412
Ethyl Corp.....188-189
Evershed & Vignoles Limited.....104A

F
Felt Products Mfg. Co.....488c
Ferro Corp.....172
Fischer & Porter Co.....11
Fish Engineering Corp.....465
Fisher & Ludlow Ltd.....105
*Fisher Governor Co.....92-93
Flexonics Corp.....339
*Flint Steel Corp.....86
Fluid Systems, Inc.....83
The Fluor Corp.....2
*Fluor Products Co.....375
*Food Machinery & Chemical Corp...173
The Foxboro Co.....76-77, 178-179
*Fram Corp.....110

PETROLEUM REFINER, NOVEMBER, 1957

* The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1957 Refinery Catalog.

G
*The Garlock Packing Co.....53
Gas Atmospheres, Inc.....156
*General American Transportation Corp.....13
General Chemical Division Allied Chemical & Dye Corp.....127
The Girdler Co.....170
The Globe Co.....386
Claud S. Gordon Co.....354
W. R. Grace & Co.....431
*Graham Manufacturing Co.....420
*Graver Tank & Mfg. Co.....6, 167
Great Lakes Carbon Corp.....382
A. P. Green Fire Brick Co.....74
*The Griscom-Russell Co.....371, 372
Gunite Concrete & Const. Co.....487d
Gustin-Bacon Manufacturing Co..356-357

H
*Hammond Iron Works.....98
The Harshaw Chemical Co.....52
Hartzell Propeller Fan Co.....437
*Haynes Stellite Co. Division Union Carbide Corp.....97
*Hendrick Manufacturing Co.....471b
Hercules Powder Co.....155
*Homestead Valve Manufacturing Co..102
Hooker Electrochemical Co.....65
Houdry Process Corp.....33
*Hudson Engineering Corp.....121

I
Industrial Process Engineers.....418
*Ingersoll-Rand Co.....29, 387
The International Nickel Co.....158

J
Jefferson Chemical Co.....10
*Jerguson Gage & Valve Co.....376
*Johns-Manville Corp.....28, 174
The Johnston & Jennings Co.....424
*Jones & Laughlin Supply Division..177
Jones, Tate & Co., Ltd.....104Ca

K
*Keasley & Mattison Co.....449
*The M. W. Kellogg Co.....116-117
The C. M. Kemp Mfg. Co.....157
Kinney Manufacturing Division The New York Air Brake Co.....407
*Richard Klinger Ltd.....365
*Maurice A. Knight.....478a
*Koch Engineering Co.....493

L
Ladish Co.....457
Langley Alloys Ltd.....104Da
Lapp Insulator Co.....119
Layne & Bowler Pump Co.....430
*Warner Lewis Co. Division Fram Corp.....110
LimiTorque Corp.....88
Linde Company Division Union Carbide Corp.....56
Lukens Steel Co.....454-455
*The Lummus Co.....329

M
*The Mack Iron Works Co.....482c
Madsen Works Baldwin-Lima-Hamilton Corp.....488b
*Magnetrol, Inc.....475b
Manning & Lewis Engineering Corp.....480b
*Jas. P. Marsh Corp.....87
*Mason-Neilan Division Worthington Corp....384-385
Mathieson Chemicals Olin Mathieson Chemical Corp.....125
Arthur G. McKee & Co.....363
*The Mercoid Corp.....470a
*Metallo Gasket Co.....471a
*Metal Textile Corp.....347, 349
Midcontinent Tube Service, Inc.....487c
Milton Roy Co.....91, 351
*Minerals & Chemicals Corp. of America.....380
*W. K. Mitchell & Co.....129
*Mixing Equipment Co.....184
Monsanto Chemical Co.....81, 393
*Samuel Moore & Co.....137
Mundet Cork Co.....480a

N
*National Airoil Burner Co.....474a
National Aluminate Corp.....333
National Carbon Co. Division Union Carbide Corp.....383
National Tube Division United States Steel Corp.....82, 417
New England Tank & Tower Co....442
New England Valve Corp.....111
*The New York Air Brake Co...407, 484b
Newalls Insulation Co., Ltd.....106
Niagara Blower Corp.....487e
*The C. W. Nofsinger Co.....438
*Nooter Corp.....379
*W. C. Norris, Manufacturer Division Dover Corp.....345
*Norton Co.....64, 161
Norvell-Wilder Supply Co.....162-163

O
*Oakite Products, Inc.....4
The Ohio Injector Co.....45
*The Ohio Steel Foundry Co.....459
*Oil Well Supply Division United States Steel Corp.....7
The Okonite Co.....443
Olin Mathieson Chemical Corp. Industrial Chemicals Division.....125
*Orbit Valve Co.....133
*Owens-Corning Fiberglas Corp.....473

P
Pacific Tube Co.....165
Packed Column Corp.....470b
Ralph M. Parsons Co.....40
The Patterson Foundry & Machine Co., Subsidiary of Ferro Corp.....172
*Peabody Engineering Corp.....434
*Peerless Manufacturing Co.....123
*Penberthy Manufacturing Co. Division Buffalo-Eclipse Corp.....468
Pennsylvania Flexible Metallic Tubing Co.....484a
Perfect Circle Corp.....390
Perkin-Elmer Corp.....151
*The Permutit Co. Division Pfaudler Permutit Inc....152
*Petreco Division Petrolite Corp.....68
*Petro-Chem Development Co.....100
*The Pfaudler Co.....54-55, 152
*Pfaudler Permutit Inc.....54-55, 152
Phelps Dodge Copper Products Corp.....14-15
Philadelphia Gear Works, Inc.....88
Pittsburgh Corning Corp.....70
Plibrico Co.....475a
Podbielniak, Inc.....35-38
*H. K. Porter Company, Inc.....334, 398
*Posey Iron Works, Inc.....479a
Horace T. Potts Co.....118
The Wm. Powell Co.....114
Preformed Metal Products Co.....408
Procon Incorporated.....399
*Proportioneers Division B-I-F Industries, Inc.....191
Puget Sound Fabricators, Inc.....486a
The Pyle-National Co.....21

Q
The Quaker Oats Co.....17
Quaker Rubber Division H. K. Porter Company, Inc.....334

R
*R-P & C Valve Division American Chain & Cable Co.....426
Rectorseal Division Rector Well Equipment Co.....466a
RedHeugh Iron & Steel Co., Ltd...104Bb
*The Refinery Catalog.....342-343, 473
The Refinery Engineering Co.....171
Reynolds Metals Co.....99
Rheem Manufacturing Co.....436
Rhodia, Inc.....476a
*Rochester Manufacturing Co.....112
*Rockwell Manufacturing Co.....71, 72
*Rockwood Sprinkler Co.....355, 453
Roots-Connersville Blower Division Dresser Industries, Inc.....94

S
*Saree Co.....192
Schutte & Koerting Co.....486c
*Scovill Manufacturing Co.....367
*Selas Corporation of America....358-359
*Serck Tubes Limited.....104
Service Foundry, Division Avondale Marine Ways, Inc.....483a
Shand & Jurs Co.....25
Sheffield Division Armco Steel Corp.....48
Shippers' Car Line Corp. Division ACF Industries, Inc.....433
*M. B. Skinner Co.....482d
*S. Morgan Smith Co.....456
Solar Aircraft Co.....39
Solvay Process Division Allied Chemical & Dye Corp.....419
Southern Engine & Pump Co.....479b
Southwestern Engineering Co.....69
Sparkler Manufacturing Co.....146
Speedline Stainless Steel Fittings Division Horace T. Potts Co.....118
Stauffer Chemical Co.....159, 409
The Stearns-Roger Mfg. Co.....124
*Strahman Valves, Inc.....489
*Stratford Engineering Corp.....481
A. A. Straub Co.....479c
*Struthers Wells Corp.....113
*Sun Shipbuilding & Dry Dock Co.....122

T
*Taylor Instrument Companies....450-451
Tennessee Coal & Iron Division United States Steel Corp.....82, 147
*The Terry Steam Turbine Co.....120
The Texas Company.....458
Texas Metal Fabricating Co.....377
Thermal Research & Engineering Corp.....459
Thermon Manufacturing Co.....460a
Arthur Tickle Engineering Works..488a
The Timken Roller Bearing Co.....16
*Tretolite Co.....166
Truland Chemical Co.....476b
*Tube Turns.....405-406
Tubular Products Division The Babcock & Wilcox Co.....150

U
*Union Asbestos & Rubber Co.....57
*Union Carbide Corp.....56, 97, 383
Union Wire Rope Corp.....128
United States Gasket Co.....397
*United States Gauge Division American Machine & Metals, Inc..403
United States Pipe & Foundry Co.....410-411
United States Steel Corp...7, 82, 147, 417
United States Steel Export Co.....82, 147, 417
United States Steel Supply Division United States Steel Corp.....82, 147
*The United States Stoneware Co.....485
Universal Oil Products Co.....18-19, 79

V
Vanton Pump and Equipment Corp. Division Cooper Alloy Corp.....486b
*Henry Vogt Machine Co.....108-109
Vokes Limited.....104Db
*J. H. H. Voss Co.....460b
*Vulcan Manufacturing Division Vulcan-Cincinnati, Inc.....396

W
*W-K-M Division ACF Industries, Inc.....78
*W-S Fittings Division H. K. Porter Company, Inc.....398
The E. H. Wachs Co.....486d
Wagner Electric Corp.....50
Walsh Refractories Corp.....464
Warren Petroleum Corp.....360
Western Supply Co.....175
Westinghouse Electric Corp...41-43, 190
*Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc.....389
Westvaco Mineral Products Division Food Machinery & Chemical Corp...173
Wheaton Brass Works.....138
The Whitlock Manufacturing Co.....130
*The Gustav Wiedeke Co.....472
A. R. Wilfley & Sons, Inc.....414
*Thomas C. Wilson, Inc.....132
*Wolverine Tube Division Calumet & Hecla, Inc.....337, 338
Worcester Valve Co.....428
*Worthington Corp.....384-385
Wyatt Metal & Boiler Works.....494

Y
*Yarnall-Waring Co.....381
*Otto H. York Co.....422
Yuba Consolidated Industries, Inc.....20, 401

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24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
104	104A	104Ba	104Bb	104Ca	104Cb	104Da	104Db	105	106	107	108	109	110	111	112	113	114	115	116
117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136
137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156
157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176
177	178	179	180	183	184	186	188	189	190	191	192	329	331	333	334	335	336	337	338
339	341	342	343	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
365	366	367	368	371	372	375	376	377	379	380	381	382	383	384	385	386	387	388	389
390	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411
412	413	414	415	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432
433	434	435	436	437	438	439	440	441	442	443	444	445	447	449	459	460A	460B	461	462
463	464	465	466A	466B	467A	467B	468	469	470A	470B	471A	471B	472	473	474A	474B	475A	475B	476A
476B	477	478A	478B	479A	479B	479C	480A	480B	481	482A	482B	482C	482D	483A	483B	484A	484B	485	486A
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44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	
84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	
104	104A	104Ba	104Bb	104Ca	104Cb	104Da	104Db	105	106	107	108	109	110	111	112	113	114	115	116	
117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	
137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	
157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	
177	178	179	180	183	184	186	188	189	190	191	192	329	331	333	334	335	336	337	338	
339	341	342	343	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	
365	366	367	368	371	372	375	376	377	379	380	381	382	383	384	385	386	387	388	389	
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433	434	435	436	437	438	439	440	441	442	443	444	445	447	449	459	460A	460B	461	462	
463	464	465	466A	466B	467A	467B	468	469	470A	470B	471A	471B	472	473	474A	474B	475A	475B	476A	
476B	477	478A	478B	479A	479B	479C	480A	480B	481	482A	482B	482C	482D	483A	483B	484A	484B	485	486A	
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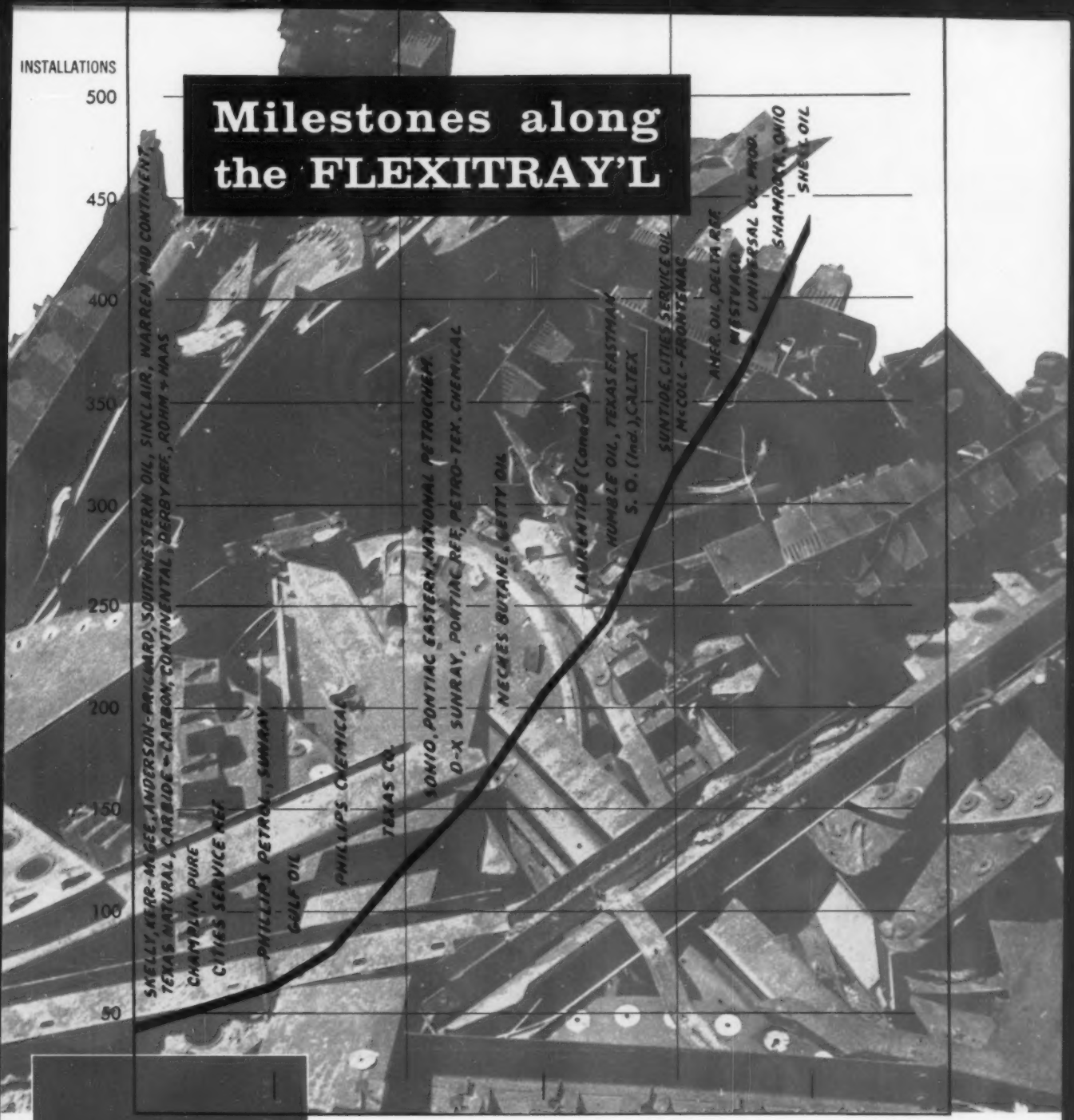

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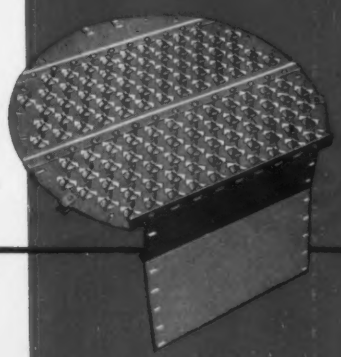

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